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Forthcoming Events.

JUNE 10.

Diesel Engine Users' Association:—Ordinary meeting in London. Paper by Arthur F. Evans, M.I.A.E., M.I.Mar.E., on "Consumers' Oil Tests."

JUNE 14.

Manchester Geological and Mining Society:—Ordinary meeting at Manchester.

Institute of British Foundrymen.

JULY 2.

Lancashire Branch:—Messrs. Tweedale & Smalley, invitation to visit their Castleton Works.

JULY 5-8.

Conference at Sheffield.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTE OF BRITISH FOUNDRYMEN; THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION, AND THE FOUNDRY TRADES EQUIPMENT AND SUPPLIES ASSOCIATION.

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The Marking of Foreign Steel Castings.

Some interesting phases of the steel foundry industry were brought to light in the evidence presented before the Standing Committee appointed by the Board of Trade under the Merchandise Marks Act, 1926, when an enquiry was instituted on the application of the National Federation of Iron and Steel Manufacturers for a marking order in respect to *inter alia* steel castings. Primarily, it was shown that 97 per cent. of the total steel production of Great Britain was made by the members of the applicant body, who were also responsible for 55 per cent. of the steel castings.

Mr. Abady, for the Appellants, suggested that the Committee should make an order that steel castings of foreign origin, weighing more than 28 lbs., that fact should be cast on a prominent part of the casting, where, in the ordinary course of manufacture it need not be machined. For castings weighing less than 28 lbs., he asked the Committee to defer their suggestion without however implying that it was impossible effectively to mark such castings.

Mr. H. G. Stobart, a prominent steel foundryman, envisaged no difficulty in casting a mark on some unimportant part which would not be subjected to subsequent machining, and considered that the inclusion of a small marked foreign casting into a machine was unlikely to give the impression that the whole apparatus was of foreign manufacture to the detriment of the British machine. He stated in cross-examination that the wheels of the London General Omnibus Company's vehicles were made in Belgium and he considered it would be beneficial to have all these castings prominently lettered in order to emphasise to the public that they are travelling about London on foreign wheels.

This point was later taken up by Mr. Percy Donald, who cited the case of a lawn mower which might contain a small part made abroad and be prominently so marked so as to give the impression of complete foreign origin, whilst wholly foreign machines could enter the home market freely without any origin being disclosed.

We believe that an order for the marking of foreign castings would be appreciated by the steel foundry industry, with perhaps, one exception, which possesses a foundry abroad, and may have found that for certain castings they can import more profitably from the foreign establishment than they can manufacture in their British foundry. Whilst the object of the inquiry is to establish whether buyers are assured of receiving British-made goods when desired or ordered, one cannot ignore the possibilities of the creation of difficulties for the foreigner to the benefit of British foundries. As an industry, it will appreciate any help which can be given to it, for during the last seven years an important percentage of British steel foundries have ceased to function. Without any research whatsoever four names associated with the Tyne, five in the London area, two in Birmingham, one in Sheffield, readily come to the minds of those connected with the industry. Despite this doleful story, we still possess some of the largest and best equipped plants in Europe, but even they would appreciate a little "oil," such as an order by the Committee would provide in order to grease the wheels of commerce.

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Progress in Iron Founding.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I read with interest your editorial comment on the portion of Prof. Carpenter's Paper that deals with cast iron. Are we not in danger of falling into the same error that was made over a previous forward step, viz., Prof. Turner's silicon investigation? The misapplication of this useful discovery has done more to lower the physical properties of cast iron than a little. The poor wearing properties of machine tools received during the earlier years of the war from America, with their 3 per cent. silicon, are an outstanding example.

Now it is generally taken for granted that cast iron of any composition that shows a pearlitic structure is about the strongest iron for that particular composition. This does not mean of necessity that it has high physical properties. It may be so interspersed with flaky graphite, phosphides, or sulphides, that it is weak. The photos recently shown in Mr. Allison's Paper were all pearlitic, but only registered just over 9 tons tensile. The D bar mentioned in my A.F.A. Paper, while having this desirable structure, due to the fact just mentioned, did not give 9 tons tensile.

Coming now to the hot-mould process. There is no doubt as to its value when castings have to resist growth and be strong at comparatively high temperatures. Not alone from its pearlitic structure, but even more because it is possible to use lower silicons and still obtain a casting that will machine. Donaldson found that of two specimens, both made by the Lanz process, the one that contained 0.6 per cent. Si was much more resistant to growth and gave better physical results at 500 deg. C. than the one that contained 1.0 per cent. Si. Unfortunately it is hardly possible to apply the hot-mould process to certain castings because of their bulk or shape. Perhaps of most importance is the need for a material that will stand up to greater superheat and higher pressures in turbines, if the latter are to meet the advance in Diesel engine work. It takes time to assemble the mould of a large turbine casing and the mould is cold by the time it is ready for casting. To lift and put a large mould of this description in a stove is a problem, and even if it were possible the danger of breaking the vents in the steamway is great. To heat up in position, to any appreciable degree, is practically impossible. Any hot-air ducts would throw the heat on isolated pieces of the core, causing burning, erosion of the sand, and a dirty casting. The only course then is to raise the silicon and obtain the pearlitic structure by composition alone. Good progress is being made to resist growth under these conditions by lowering the carbon and the addition of chrome and nickel.

When one deals with castings that only meet the everyday steam temperatures, I fail to see the need for the hot-mould process. I was recently privileged to see a set of micros cut from two similar castings. The one was made by the Lanz method, the other in an ordinary dry-sand mould with a controlled composition. No difference could be found in the structure, and the English company had a slight advantage in the physical results. This agrees with the published statement recently made by M. A. le Thomas, who is responsible for many of the engine castings for the French Navy. He keeps the C., P., and S. as near constant as possible, and obtains the pearlitic structure by varying the Si and Mn content to suit the thickness of the casting. Thin pieces are either poured very hot or else in a warm mould. In both cases the speed of cooling is slower. The "Emmel" process also does not depend on producing its pearlitic structure from hot moulds, while the ordinary tests show even higher results at room temperatures.

I have written the above, not to detract in any way from the excellent work done by Herr Sipp and his colleagues, but to show that equal results are possible in another way, and to give a warning against the use of such diagrams as "Maurer's," which ignores the influence of such vital essentials as tapping temperatures (see Piwowarsky's diagrams); influence of Mn, P and S; casting thickness, cooling effects, and mould temperatures. A knowledge and control of these vital points are quite as essential to obtain a strong casting as are the control of carbon and silicon set forth in the first-mentioned diagram.—Yours, etc.,

J. SHAW.

Brightside Foundry, Sheffield.

Do Fillets Always Strengthen a Casting?

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In your issue of April 28 there appears "A Note on Fillets," by J. McLachlan, wherein a statement is made which strikes one as being somewhat incorrect. The author states that fillets, although not always wanted, *always* strengthen a casting. May it be suggested that "generally" would have been a much better alternative to that positively committal word "always." The question of fillets is one of much greater importance than it often appears. Misuse or bad design when employing fillets may quite easily greatly weaken a casting, although to all appearance it seems strengthened.

Take, for example, a cast-iron pipe, as shown in Fig. 1. For explanatory purposes the fillet has been considerably exaggerated. A large fillet here would without doubt weaken the casting at the point A through crystallisation of the metal caused by sudden change in cross section; in fact the casting would be much stronger with only the slightest suggestion of a fillet. Such mistakes in design are often apt to occur in the average foundry, and it is up to the draughtsman to keep such points in mind when designing his material. Only practical observation and experience can bring him nearer to the acme of perfection in such questions of design. Sudden change of section is

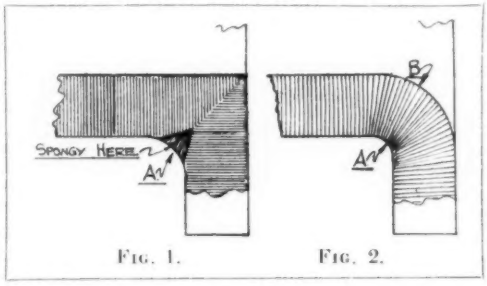


FIG. 1. FIG. 2.

sometimes unavoidable in a casting, but wherever possible it should be compensated by careful design and practical aptitude.

In Fig. 2 is illustrated this feature, the casting being similar in design to that of Fig. 1. It will be observed, however, that no direct change of section takes place, the corner B being sufficiently radiused to maintain uniformity of section. In this case a good fillet is necessary at point marked A. Now take a comparison of Figs. 1 and 2. Undoubtedly the latter one is much superior in strength to that of the former. Maybe numerous other examples may be pointed out where the use of fillets calls for great care. The size of the fillet to be used is another point of no little importance, and should always be decided by the members of the drawing office. (Assuming, of course, that the foundry possesses such a valuable asset.)

Good supervision and management leaves nothing to chance whenever possible. Above all, leave nothing to be decided by the moulder, for when all is said and done he is only there to mould the casting. One cannot expect him to know what every casting is required for and what peculiarities of design it must have. By this one does not mean the thing to be carried to the extreme by pestering the foreman of each department with the most trivial matters. Most things call for a certain amount of common sense and judgment, and this case is no exception to the rule.—Yours, etc.,

VALLISCHE.

Some Aspects of Foundry Work.*

By E. Longden.

(*Continued from page 465.*)

Construction of the Mould.

The next sketch, Fig. 6, gives a clearer and a more detailed description of the construction of the mould and suspended cores to ensure, as near as possible, true safety. The core is required to be soundly made and with good venting. Since much difficulty can be foreseen to extract the core irons after casting through such comparatively

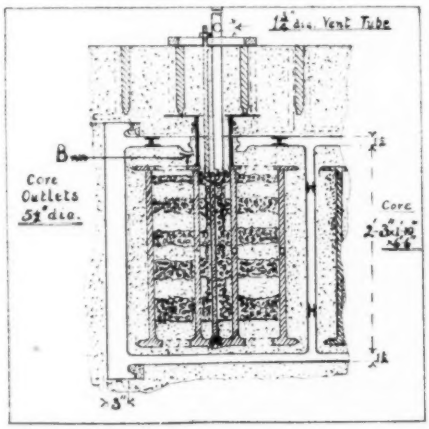


FIG. 6.—DETAILED DESCRIPTION OF THE CONSTRUCTION OF THE MOULD AND SUSPENDED CORES.

small apertures, care must be taken to make the core supports in metal which will allow of easy breaking into pieces no larger than 5 in. to pass through the restricted core outlets. Strength is maintained in the core by ramming up with an outside layer of strong sand and on the inside with alternate layers of medium-bonded sand and cinders for venting. Each layer of cinders communicates with a central column of cinders which leads to the surface of the core just below the neck. The most vulnerable part of the core, the outlet for the gases, is specially cared for. It will be noted that the sketch indicates that a cast iron or steel bush is built into the neck of the core and seated solidly down on the core iron. Around the bush is rammed a strong mixture of stiff loam into which has been worked a little core gum. The top boxes are also carefully made. Metal reinforcements are introduced to correspond with the bushes in the cores and rammed with strong facing mixture.

Arrangements for coring the mould are made by first bolting the side cores into position, locating the crank core and then those to be suspended from the top boxes are placed in the open mould and resting on wooden thickness pieces equal to the desired metal section. Studs are placed between the cores to lend steadiness when bolting up to the top side. Small pieces of clay are placed on the top of the cores to ascertain the metal section and for positioning a number of studs to lend further steadiness to the hanging cores. Around the top of each core outlet is placed soft loam covered with paper. The top boxes are then located for the first time after drying the mould. The soft loam is squeezed between the lower face of the top boxes and the top face of the core outlets, effectively sealing any crevice through which metal might otherwise find ingress to the core. The top boxes are again lifted off and all loam which has been pressed beyond the area of the core outlets and central portion through which gases must pass is trimmed off and well dried with hot irons. Studs are placed in various positions on the top of the cores, the location and section having been previously ascertained by the clay impressions and the top boxes again located. The cores are firmly bolted to the top-part boxes by passing hook bolts through the holes prepared and under staples cast in the core grid. The boxes are again lifted and set on suitable logs; whilst in this position the moulders give a further touch of safety by wet blacking around each of the core outlets, using a small brush on a long handle. More studs are located, and on the top side of the boxes vent tubes are placed alongside the hook bolts and penetrating right through the top boxes and into the cinders below the neck of the core. Sand is then carefully rammed around the vent tubes. The mould is finally closed and poured.

The most skilled attention is needed to ensure that no metal enters the core vents. If cores were simply placed on studs resting on the bottom face of the mould many things might happen to cause this expensive casting to be lost. With cores and mould so constructed very little risk is taken. Even if the top boxes lifted a little during pouring the casting may still be saved because the core vents would still be secure.

Two Grades of Metal in the Same Casting.

An incident during the American foundry tour reminded the author strongly of similar work done by him 11 years ago. During the journey round one of the jobbing foundries he stopped to question the foundry manager concerning the reason for employing two sets of gates and consequently two ladles to pour a lathe-bedplate weighing about 8 tons. The casting was bulky and about 16 ft. long × 8 ft. wide, thereby being quite safe if run from two or three places at one end of the casting. He had also remembered that previously he had seen among other ladles one of 25-ton capacity. The manager's answer was that he poured a strong semi-steel mixture into the lower part of the mould, which constituted the working and wearing surfaces. When enough semi-steel had been poured to fill just above the important parts they ceased pouring; at the same moment a low grade of cast iron was poured from the waiting ladle at the other end of the box at a higher level and the mould completely filled. The ratio of metals was about 25 per cent. semi-steel on the bottom side and 75 per cent. common iron to complete filling.

Making a Lathe Bedplate.

To illustrate this practice a little further sketches are reproduced of the moulding of a lathe bed which the author contributed as an article* to THE FOUNDRY TRADE JOURNAL.

Fig. 7 shows the plan and elevation of a lathe-bedplate 38 ft. 5 in. long. Whilst this casting is much longer and lighter in section than the one referred to, it is a much heavier casting as a whole. The idea, of course, is to fill the faces there marked A and B, which are cast the reverse way up to that in the sketch with a strong, close-grained cast iron obtained by introducing 35 per cent. steel into the cupola mixture.

Fig. 8 shows the arrangement of the in-gates when pouring such a casting. In this instance the author employed four in-gates at each end of the long mould. Until a later stage in the pouring the two sets of in-gates at the higher level were stopped up by placing plugs over the down-gates in the pouring basin. When sufficient metal had been poured through the lower set of in-gates from each end to fill 25 per cent. of the mould, the stoppers or plugs which controlled the flow of metal to the higher level of the mould were lifted, allowing a hotter metal to occupy the top surface of the casting. This arrangement was found to give better control over the camber, or distortion, because it ensures a more uniform temperature of metal over the whole of the mould; also the bottom side of the casting was cleaner, due to less metal passing the lower levels which may cause erosion and scabbing of the mould face; again, the metal

* A Paper read before the Lancashire Branch of the Institute of British Foundrymen, Mr. J. S. G. Primrose, presiding.

* See THE FOUNDRY TRADE JOURNAL, vol. 25, p. 155.

in the bottom faces which were the important sections of the casting tends to be of closer grain and freer from gas cavity due to an earlier freezing than would otherwise obtain if the whole of the metal passed through at the lower level to fill the higher reaches of the mould.

iron for the cores (Fig. 13), grid for lift between feet in top part boxes, and feet core with its accompanying grid.

Stamp Block Castings.

As pointed out earlier in this Paper, the practice of pouring two grades of iron into the same

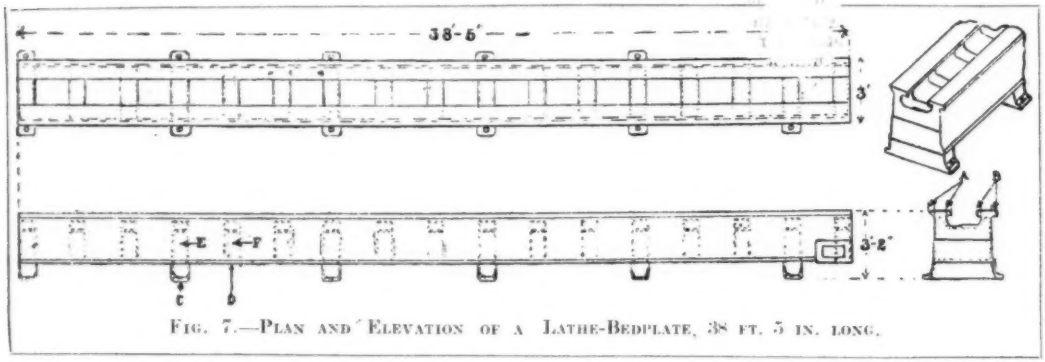


FIG. 7.—PLAN AND ELEVATION OF A LATHE-BEDPLATE, 38 FT. 5 IN. LONG.

It would be possible to pour even such a long casting with two grades of cast iron, but it means bringing into action four ladles, two to pour semi-steel in through the bottom in-gates from each end and two to pour later at the higher level. However, it is thought preferable to secure economy

mould reminded the author of the time when he regularly cast stamp blocks and dies with a facing of steel on the working surface and grey iron the remainder of the casting.

Fig. 16 illustrates the procedure. "A" is a sketch of a casting and "B" the mould for same.

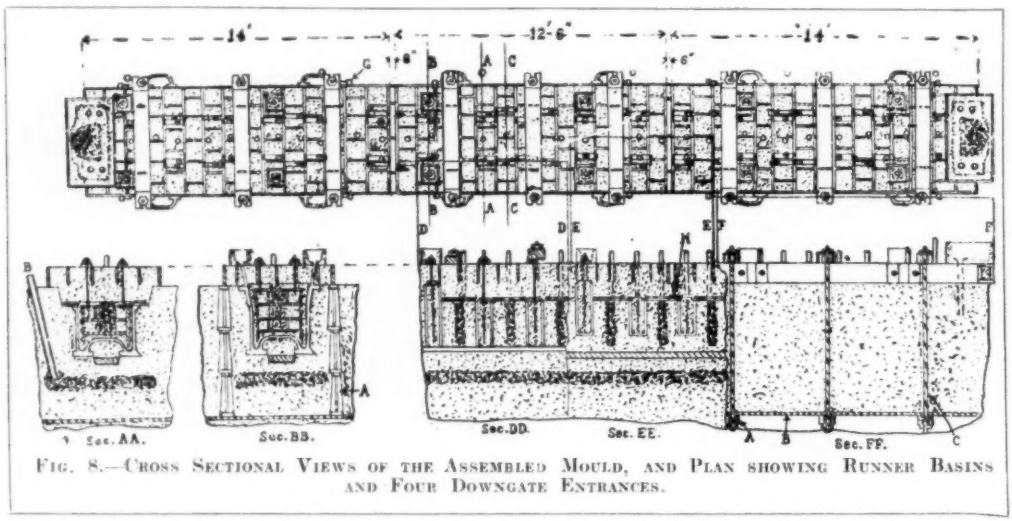
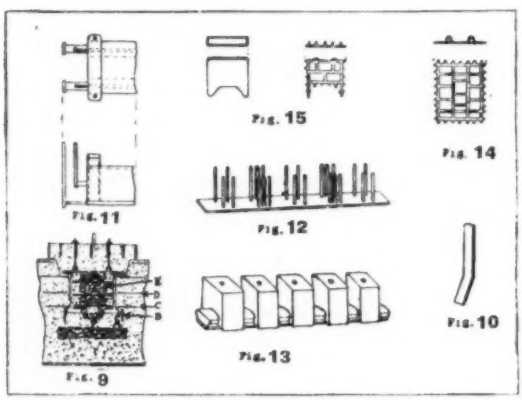


FIG. 8.—CROSS SECTIONAL VIEWS OF THE ASSEMBLED MOULD, AND PLAN SHOWING RUNNER BASINS AND FOUR DOWNGATE ENTRANCES.

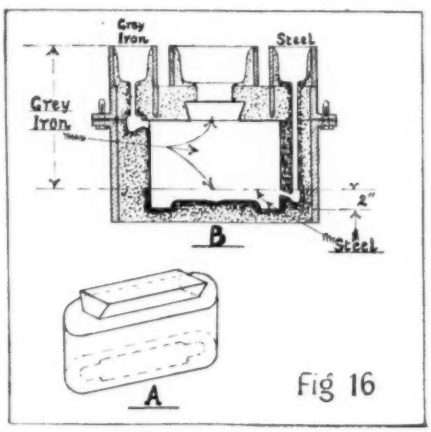
by using a series of chills along the important faces and pour with a moderately strong iron, which has been done with smaller castings.

The sketch (Fig. 8) shows a series of cross-sectional views of the assembled mould and a plan

About 2 in. of steel is poured into the mould at the low level. Almost immediately after the steel is poured the common grey iron is filled in at the higher level. The specific gravity of the steel ensures that it remains settled at the lower level,



FIGS. 9—15.



view with the runner basins and the four downgate entrances at each end, whilst Figs. 9, 10, 12, 13, 14 and 15 illustrate respectively cross-sectional view of mould, special sand rammer, core

amalgamation of the two metals only taking place at the contact line. This method was practised because of cheapness. The castings were very satisfactory and had a long life.

Moulding Hydraulic Cylinders, Rams and Heavy Fly-wheels with Special Reference to Moulding-box Construction.

In many districts both medium and heavy castings are loam-moulded ... strong cast-iron rings or plates with vert... s cast thereon to hold in the bricks and ...aterial. Such is the practice when usin... ...s and templates, etc., or building to skel... full pattern.

There are quite a ... ...r of founders who place the finished mould in a pit and ram around the outside with black sand. The author has had cast thousands of tons of large castings made in such a mould without having to incur the expense of ramming and again removing a large body of sand around the mould in the casting pit without the loss of a single casting. There are well-known founders in the Manchester district and elsewhere who are carrying on in the same way with real success.

The production of hydraulic rams and cylinders can be carried out in boxes which will eliminate the need for the extra ramming of sand around the boxes.

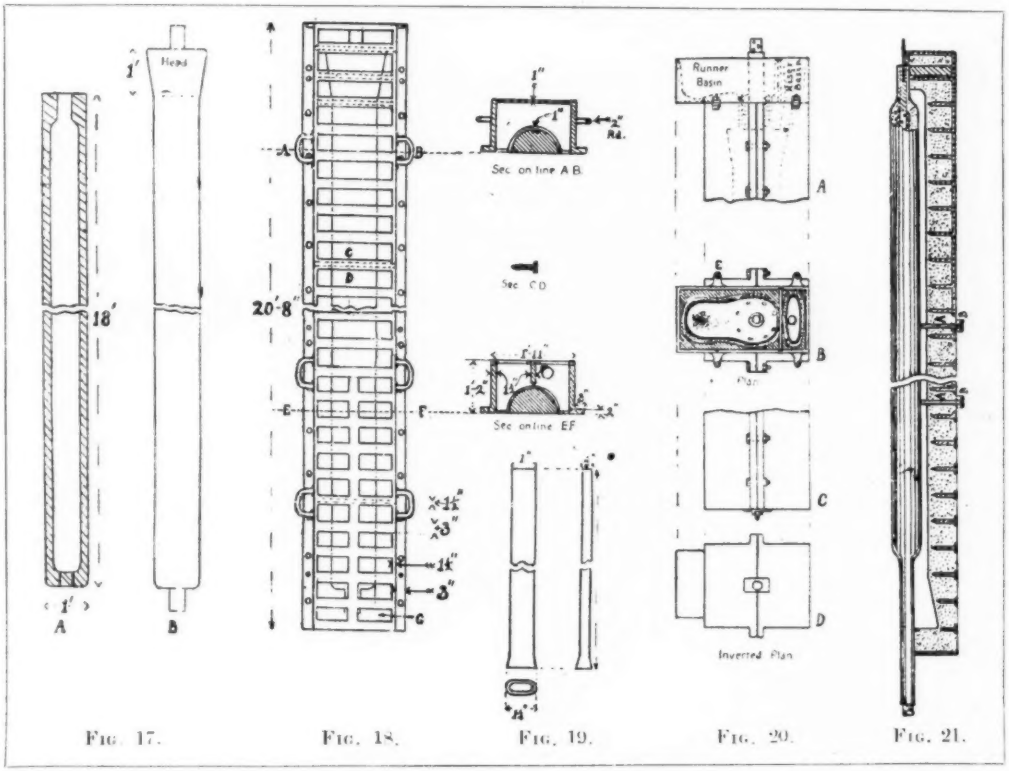


FIG. 17. FIG. 18. FIG. 19. FIG. 20. FIG. 21.

Fig. 18 illustrates the boxes and a method of moulding hydraulic rams, whilst cylinders can also be made similarly.

At A, Fig. 17, is shown the section of a medium-sized hydraulic ram with a 12-in. sullage and sink head cut off, and B outlines the necessary pattern. Fig. 18 gives the construction of the strong moulding box suitable for making ram and cylinder castings therein, without having to resort to the ramming around the outside of the box. Each half-box is made in two or more parts, according to the length of the casting required, and bolted together. The joints are then machined. CD shows above Fig. 19 the shape of the bars which form a T head partly boxing in the sand and helping greatly to withstand the outward pressure of the metal whilst pouring. Section AB seen above Fig. 19 shows a cross-sectional view of the upper part of the box which runs about two-thirds of the total length, and EF indicates the construction of the lower portion of the box. In this lower part of the box an additional bar is introduced and runs vertically in the centre for about 6 ft. from the bottom end.

With a box so made and the parts well bolted together at intervals of about 12 in. a burst-out or runaway is very unlikely. The mould is made horizontally and constructed very soundly in strong refractory sand. Stiff loam is worked on the pattern at what will be the bottom end when pouring vertically, and the remainder of the pattern is faced with a strong sand. For about half the length of the box (the bottom end) it is advisable to ram in a stronger sand than that from the floor heap. A mixture of half black and half core sand can be recommended. The remainder of the box is rammed with black sand which has been wetted with clay-water.

After extracting the pattern, the mould at the bottom end is studded with flat-headed nails to receive the heavy impact of the first metal poured. The mould is well blackened with a good mineral blacking, and, after drying again, washed over with a thin solution of good plumbago blacking and gum water. Fig. 19 shows the design of the drop gates, eight in number.

Fig. 20 illustrates with section A and B the construction of the runner and riser basins. The head is helped in its work by feeding for a short time until the runner basin is run dry by tapping into a ladle from below the runner box. Every effort is made to free quickly the top of the core bar, which is lightly tapped with an iron bar to induce it to expand upwards, otherwise the core bar may be found to be much bent when extracted from the casting.

It is the practice in some foundries to prevent lifting of the core by chaining the bar from the top side. In this case they cannot be quick enough in releasing the bar after casting, consequently the core barrel is bent. As a matter of fact, the bar and core is distorted before that stage is reached, and sometimes a waster results. This can also be proved on occasions if rams are inspected after having been scrapped and broken. The section will be found to be thick and thin instead of regular.

Section C and D show the correct way to secure the cores. The core bar is made solid to about 3 in. behind the neck of the core and a stud bolt screwed in to allow the core to be bolted down from the bottom end. Made thus, the core is allowed freely to expand whilst the metal is still being poured. Such a core is so slender that when it is located it will sit on the bottom side of the mould, and when the box is turned up to cast vertically the core is very unlikely to straighten itself. To avoid such risks two wooden pegs are placed to act as temporary chaplets, as shown in

Fig. 21. When the mould has been turned up to the vertical casting position the wooden chaplets are withdrawn and the holes vacated plugged with round cores secured by the special plates on which the wooden chaplets had been previously resting.

Heavy Flywheels.

The next example explains the moulding of a 10-ton flywheel. Fig. 22 shows in plan the pattern resting on a plate ready to receive the moulding box. The elevation of the pattern above the plate is shown below. To make a full wheel a half-pattern is made in two pieces, dividing the pattern to represent a quarter wheel, as indicated in the plan at AB. Below the plate is shown the section of the flywheel. This sketch must not be mistaken as to indicate a half-pattern on either side of a plate. The two quarter (half) patterns are located by pins on a large machined cast-iron plate set permanently on the moulding floor. On the plate are machined lines to give foot squares and are used to set the pattern dowel and moulding-box pin holes for the various sizes and types of flywheels which can be made on this one plate. Much economy in patterns and in moulding is thereby secured. When a flywheel is required in halves only one quarter-pattern is needed, and the moulding box is also disassembled to make a half wheel. When a full wheel is required the two quarters are used.

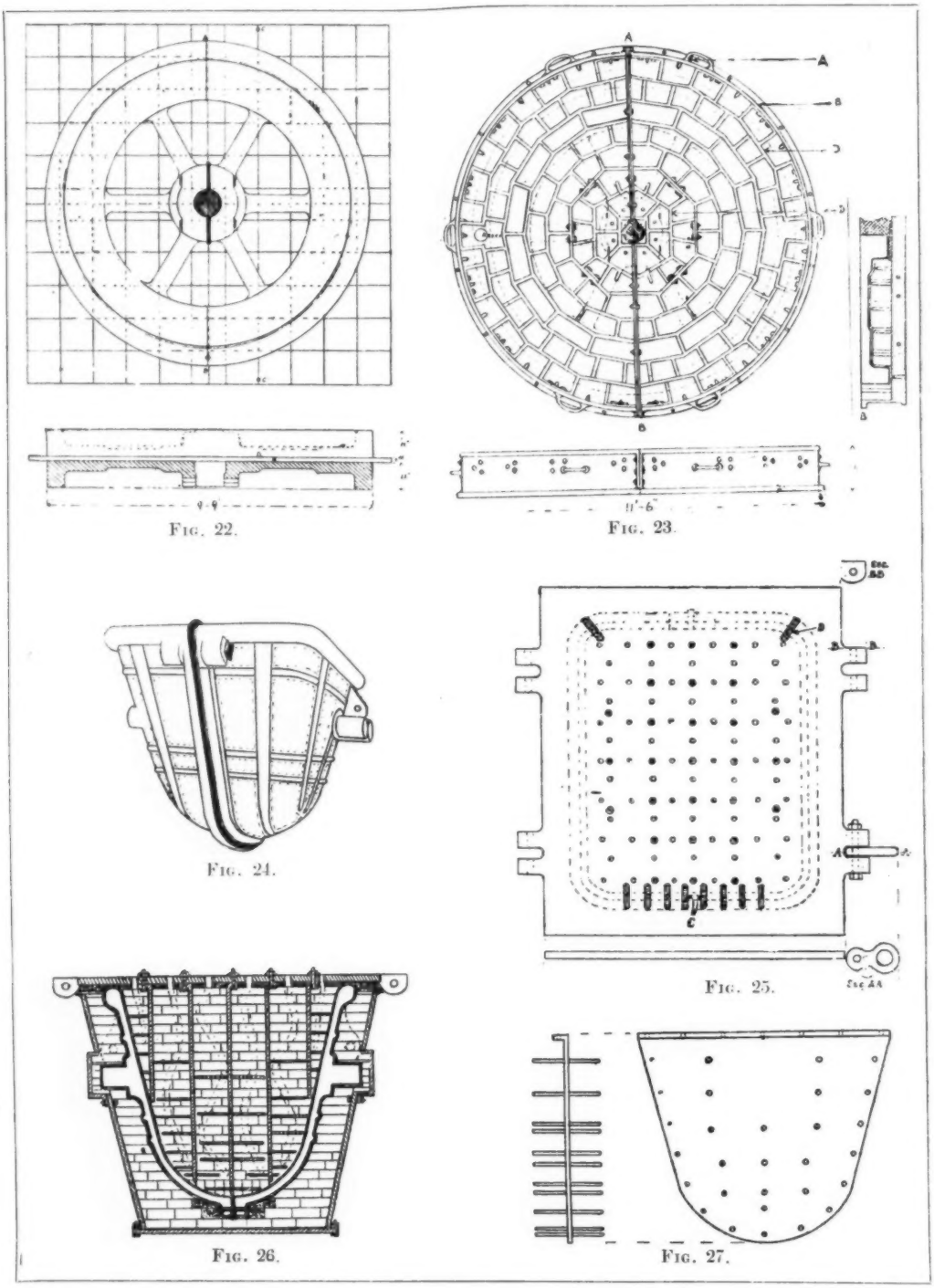


FIG. 22.

FIG. 23.

FIG. 24.

FIG. 25.

FIG. 26.

FIG. 27.

Fig. 23 illustrates the construction of the moulding boxes. Such heavy flywheels are very exacting on the moulding boxes due to expansion which takes place from the heat radiated from the heavy sectioned casting. The repeated breakages can be minimised by making the boxes in several pieces. In the example shown the moulding box is made from two pieces forming the area about the boss; this, incidentally, allows various sized bosses to be used. Two pieces make up the middle bars and the outside ring is formed again by two pieces. The sections are firmly bolted

together and they make together a very durable box. Little or no casting strains remain in such a construction.

Soon after the flywheel has been poured and the metal is set bolts are released in the various sections and at the joint of the box to allow of free expansion; otherwise the box would be broken, although not so seriously as if cast in one piece as previously.

Semi-Permanent or Long-Life Moulds.

The progress of permanent mould casting is not very substantial. Beyond the centrifugal casting process as practised by the Stanton Ironworks Company, Limited, for making pipes and that by the Centrifugal Castings Company, Limited (Thorncliffe Ironworks), for the manufacture of piston rings, liners and similar castings, and the making of carburettors in metal moulds by the Holley Carburetor Company, Detroit, U.S.A., and various other similar castings by other makers we can say that there is little progress.

There are several foundries in the U.S. making sashweights in permanent moulds with very indifferent success. There is a company in the United States installing a system of permanent moulding for making radiators, but it is thought that they have abandoned the system.

It will be found that the only castings which are made in metal moulds and made to pay are castings which give trouble when poured in sand moulds.

The author well remembers the experiments of Mr. S. G. Smith, to whom the foundry trade is so

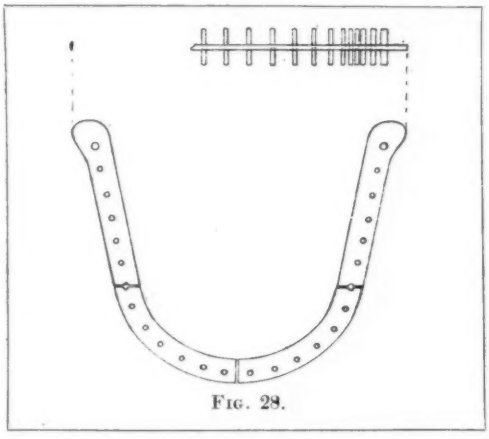


FIG. 28.

deeply indebted. It will be 15 or more years ago when he cast small valve castings in metal moulds; but, if memory is correct, the object was to secure sound castings. Mr. Feasey, foundry manager of Ruston & Hornsby, Lincoln, cast a certain small type of valve-shaped casting in metal moulds again to secure a sound casting. The Holley Carburetor Company, Limited, started off with the same object—to secure good castings. Mr. Broughhall's classical work will also be remembered. He employed certain types of cast-iron moulds to produce close-grained sound metal in the form of long sticks to be cut up to make gears, etc. Again, sound castings was the aim. Most progressive foundrymen will, from time to time, have made simple types of castings in metal moulds with indifferent success. The author has tried many times, but has come to the conclusion that it is only sensible to make castings in metal moulds when good sound castings cannot be secured by ordinary methods. Therefore, the production of castings made in metal moulds in the great majority of cases has not been finally continued with for the sake of direct cheapness, but to secure sound castings which, of course, cheapens the cost of the castings by eliminating wasters.

The cost and upkeep of permanent moulds, etc., is extremely high, and can never compete with the modern quick methods of moulding from various types of hand and power machines, and even with ordinary hand-manipulated plate patterns.

In the case of medium and light castings real economy is obtained from some form of semi-permanent mould structure. It is on record that there are founders who have produced a large number of various types of simple unimportant castings with a little preparation each time from the same mould which is made from fire bricks. The author has made similar castings in brick-lined moulds, but finds that the castings must be of thicknesses above $\frac{3}{4}$ in., otherwise blowholes will be encountered. Why this is so he has not yet been able to find out. Probably in the heavier sectioned castings gases have time to bubble through the metal and find a passage through the top face of the mould. This is most likely.

When pouring moulds vertically much greater success can be achieved from the fire-brick-lined moulds. Apart from the blowholes in the thinner castings in both thick and thin moulds, much trouble is experienced with blacking washing. Well burnt bricks should be used. They are more porous with less bonding material, which will give off gas at the higher temperature. The effort of the gas to break through the blacking causes the latter to peel, apart from lack of adhesion and expansion of the blacking face.

Many types of castings are produced in partly metalled moulds to secure either hard-wearing surfaces or soundness. Many loam moulds can be described as semi-permanent. The next series of

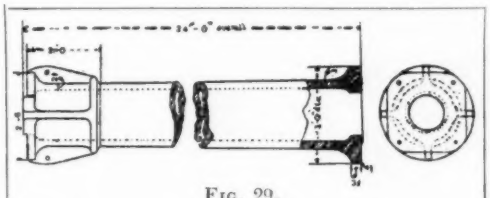


FIG. 29.

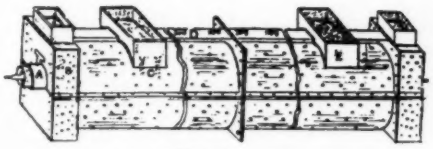


FIG. 30.

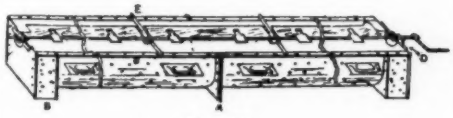


FIG. 31.

sketches can be taken as an example of what can be done in this respect.

Slag Ladles.

Fig. 24 shows the outline of the ordinary type of slag ladle, and weighs about 10 tons, although the larger sizes may reach 20 tons. Fig. 25 illustrates the strong top plate to which is soundly bolted a number of plates similar to the sketch Fig. 27. These plates are bound together and strengthened by cast-in wrought iron bars which help to hold the brickwork together. The bricks are firmly built into the metal framework. Fig. 26 gives a sectional view of the closed mould. The bottom side of the mould is constructed by building brickwork soundly into a metal casing. Fig. 24 indicates by dotted lines the kind of pattern used when moulding by this method. The pattern is first used to mould the bottom side of the casting separate from the top and then the top part is dealt with later. In both cases before placing the skeleton pattern the brickwork is well rubbed with very wet loam. The pattern is next located and loam worked behind the skeleton of the pattern and on the face between the struts. When the loam has stiffened various strickles are brought into action to form the face of the mould not produced by the skeleton patternwork. The ladles are split into halves; this is accomplished by using splitting cores, as shown in Fig. 28. Bolt hole cores are threaded through the splitting cores.

The cores at the bottom of the mould are subjected to hematite metal combined with great pressure, which produced, very often, an almost metallised core. This trouble was overcome by

arranging a mixture of 25 per cent. red sand, 25 per cent. ganister and 50 per cent. plumbago, or mineral blacking, well milled together, and, of course, well dried.

When the casting is quite set the bolts and clamps are removed and the top plate with its burden lifted about 1 in. This is done to prevent the contracting casting seizing the brickwork and plates on the top side of the mould. The whole of the brickwork, both in the top and bottom, with the exception of that above the trunnions, can be used up to 50 times. Just occasionally bricks here and there are replaced.

Heavy Furnace Column.

The next few sketches describe the moulding of a heavy furnace column in loam, weighing seven tons, and can be described as semi-permanent moulding. Fig. 29 illustrates the casting 24 ft. in length with average metal sections of 3 in.

Fig. 30 gives a view of the bottom half of the mould, with the strickle in position supported by bearers E and the end centres, and resting on a strong cast-iron casing conforming approximately to the contour of the casting. The casing is divided into four pieces, two for the top half and two for the bottom half of the mould. The casing is carefully bricked and jointed with loam. The vertical flanges (as moulded) are faced with loam brick on the inside, so that the casting on cooling will not grip the brickwork too tightly and lift out with the casting when being removed. Except around the brackets, 1 in. of loam is allowed on the face of the brickwork. The top

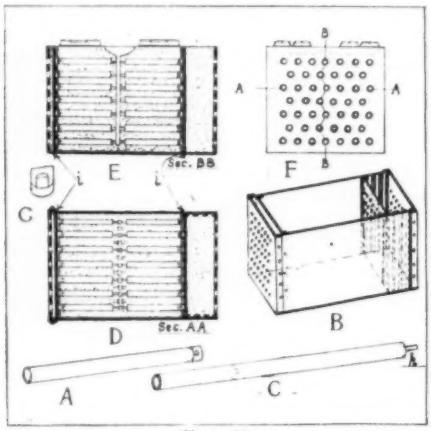


FIG. 32.

side of the mould is made in much the same way as the bottom, generally, but the brickwork is tied into the casing with suitable strong grids.

Fig. 31 describes the appearance of the assembled mould ready for pouring. A is the round cast-iron barrel core which is made in two lengths, and, when resting in the mould, is supported by strong cast-iron studs, and the side movement arrested by chaplets stretching through the metal section across the joint to the sides of the casing. D indicates pieces of wrought iron cast in the casing to receive the chaplets which hold down the two halt cores. C and E are pouring basins which feed four drop runners shown in phantom at C. Two risers are situated one on each flange.

In such cases, if ordinary care is exercised, quite a considerable number of castings can be made using the same brickwork as first set and facing again with loam as before. Many similar cases could be cited.

Moulding Sash Weights.

The method to be described outclasses any common method of permanent mould production for this simple type of casting or any similar in design with large numbers required.

A, Fig. 32, is a sketch of a sash weight weighing about 16 lbs., and C is one of a number of tubular patterns for making such castings in a box similar to the illustration B, which is a casing with an open top and two outer and inner ends each with about 46 holes corresponding to the diameter of the casting to be made therein and spaced about 2½ in. apart. One end of the box is provided with vertical slots. The inner end can be moved about in the slots to suit different lengths and weights of castings. E and D show respectively a sectional elevation and plan of the mould ready for pouring. F describes the end elevation.

The castings are poured through an inlet gate formed by the end of each of the tubular patterns, as shown at *h* in the sketch C. The horizontal ingates are fed from a series of square vertical runners which are in turn connected with a simple runner basin scooped out of the upper open side of the box. A number of weights are lodged on the top side of the open sand on each side of the pouring basin.

To commence moulding the casing B is rammed level with the lower surface of the bottom row of castings, and fourteen of the forty patterns provided are threaded through the holes at each end of the box and lie at a suitable distance from each other at the centre of the box. The first set of vertical gate sticks are then located at the end of the patterns, the ends of which form the inlet gates. Sand is next solidly rammed around and above the pattern to correspond with, again, the lower face of the next row of patterns and the second row of down gates set. After the third row has been rammed up in a similar manner the next and succeeding rows are produced by drawing out the bottom series of patterns in progress and used to fill the box with moulds of sash weights. After the box has been rammed full, the runner basin formed, and the weights bedded down, the patterns and vertical gate sticks are withdrawn. The eye in the casting is formed by an oil sand core similar to the sketch G. This core also serves to blank off the open ends of the moulds. The loose plates in sketches D and E are placed behind the inner ends of the boxes and can be held in position by wedges or ramming sand between the inner and outer end, thus effectively sealing the mould.

With all castings taken from the moulds and sand prepared overnight, a moulder produces between 4½ and 5½ tons of sash-weight castings per day. The moulder receives a price of 60 cents for a flask containing up to 7 cwt. of castings. This moulder made from ten to twelve per day. Small cores which formed the eye in the sash weights were made on an oil sand core blowing machine. From this machine a core-maker made 9,000 complete cores per day.

The very poorest grades of cast-iron scrap was collected together along with thin mild steel scrap and melted for such castings.

The Midland Building Trades Exhibition.

The Midland Building Trades' Exhibition will be held at Bingley Hall, Birmingham, from September 5 to September 17 next. The Birmingham Chamber of Commerce is again the organising body, and the Council of the Exhibition has undertaken the provision of stands on hire, fitted and erected. About 75 per cent. of the stand space has already been allotted.

Conferences will be held on the most recent developments in the building and allied trades. In this connection particular attention will be paid to the effect of the reduced Government subsidy on housing. This, in the view of exhibitors, will give a stimulus to private enterprise by introducing a new competitive spirit, and one of the first results looked for is a higher standard of middle-class home at an appreciably lower cost than has been the case for many years past. Discussions will also take place on lighting, cooking, heating, electricity services, hot-water provision and kindred subjects.

The Lord Mayor of Birmingham (Alderman A. H. James, J.P.) is the President, and the General Manager, Birmingham and Midland Building and Allied Trades' Exhibition, at the Chamber of Commerce, New Street, Birmingham, is in charge of the allocation of stands.

STEWARTS & LLOYDS, OF SOUTH AFRICA, LIMITED, are to be formed to establish works for the manufacture of steel tubes at Vereeniging.

Manganese and Ferro-Manganese.*

By Sir Robert Hadfield, Bt., D.Sc., D.Met.

(*Continued from page* 461.)

(B) THE PRODUCTION OF FERRO-MANGANESE AND ITS HISTORY.

The principal commercial alloys of iron and manganese are ferro-manganese and spiegel, including silico-spiegel. Ferro-manganese is a generic term for the crude pig metal containing in practice usually about 80 per cent. Spiegel ranges from 5 to 20 per cent., but the higher percentages are those for which there is most demand. Silico-spiegel contains 15 to 20 per cent. manganese, and about 10 per cent. silicon. All these materials contain carbon, averaging about 6 or 7 per cent. in ferro-manganese, 4 or 5 per cent. in spiegel, but usually less than 5 per cent. in silico-spiegel. The presence of carbon is, in some respects, a disadvantage in experimental and research work, yet it is a curious and interesting fact that had the author been able, in the early days of his experimental work, to obtain high-grade ferro-manganese as free from carbon as is now possible, he might in all probability have missed making the discovery of manganese steel—a discovery which, in the opinion of many eminent metallurgists, has proved to be one of considerable importance, and of which the late Professor Floris Osmond said that it was one which ranked in the same order in the history of metallurgy as the discovery of the effect of quenching on carbon steel.

History of Ferro-Manganese.

Acknowledging his indebtedness for much of his information to Kohn's "Iron and Steel Manufacture," published in 1868, the author states that at the British Association meeting held in Birmingham in 1865, in the Mechanical Science Section, as it was then termed, and preceded by an address from Sir William Armstrong, K.C.B., F.R.S., President of the Section, there appeared a Paper on "The Manufacture of Cast Steel: Its Progress and Employment as a Substitute for Wrought Iron," by Sir Henry Bessemer—that is, nine years after his first Paper was read before the same Association. After dealing with the many difficulties to be overcome in the manufacture of his steel, he pointed out how in 1839 the trade of Sheffield received an enormous impulse from the invention of Josiah Marshall Heath, in his patent covering the employment of metallic manganese, or, as he called it, "carburet of manganese." Sir Henry Bessemer then detailed the phases of the Mushet case, and finally added that "at the suggestion of the author (Bessemer) works for the production of manganese alloys were erected by Mr. Henderson of Glasgow, who now makes a very pure alloy of iron and manganese containing from 25 to 35 per cent. of the latter metal, and possessing many advantages over spiegel, which it will doubtless replace."

Sir Henry showed, at the reading of the Paper, specimens of the steel made with the new Henderson alloy in lieu of spiegeleisen, which, he added, "is incapable of making steel of such a tough quality." Two bright rods 1⅛ in. in diameter were exhibited doubled up cold under the hammer.

As showing the curious ideas then prevailing (1863), Mr. G. Parry, of the Ebbw Vale Ironworks, stated that whilst he admitted manganese was a corrective of red shortness, it rendered steel more brittle while cold. In order, therefore, to avoid having recourse to manganese, it would be necessary to employ more powerful machinery for rolling steel than was then generally in operation. No doubt confusion here came about with the higher carbon necessarily present in such steel in the days when only spiegeleisen was available.

In 1871 Ferdinand Kohn, an original member of the Institute, read a Paper on the production of alloys of iron and manganese. The position is there fully described with reference to the production of what was at that time an important metal known as spiegeleisen, obtained from the district of Siegen, in Rhenish Prussia.

It is particularly interesting to note what was said by Mr. (afterwards Sir Henry) Bessemer in the discussion on Kohn's Paper. He said that fifteen years previously (1856) "He had with some difficulty produced several pounds of metallic manganese entirely free from any alloy. Some of this metal he had added to pure decarbonised fluid iron, the result being the production of homogeneous iron of extreme toughness, which greatly resembled copper in its powers of extension and alteration of form without fracture, both in its cold and heated state."

Unfortunately Sir Henry Bessemer did not mention in what way he had produced this metallic manganese, nor what were the percentages of manganese added to the iron; neither can the author find any other references to his experimental work in this direction.

From the information now presented, however, with regard to Sir Henry's work on manganese, it is apparent that, with his usual ability and foresight, he saw the enormous importance of the metal manganese, the practical applications of which he pursued with characteristic energy. It was without doubt largely his stimulation in this matter, especially exemplified by the energetic way in which he assisted in pushing forward the production of ferro-manganese by the Henderson process, which aroused so much interest in the development of alloys of ferro-manganese in contradistinction to spiegel, and led ultimately to the valuable applications of them which resulted. He was also the first to point out in his specification, in which he likewise described its manufacture, the benefits derived from the application to the Bessemer process, and eventually to other processes, of steel-making, of the valuable alloy now known as silico-spiegel—that is, a combination of iron, manganese and silicon—in place of the ordinary spiegeleisen.

Before the days of the introduction of the Bessemer and open-hearth methods of making steel, no one took much real interest in the application of the metal manganese or its compounds to ferrous metallurgy; in fact this element, for the type of steel then produced, was only required in what might be termed minute percentages. It has to be borne in mind that at that time practically the only method of producing fluid steel was by the crucible process, and this was not more than about sixty years ago.

Steel melted and produced in this manner—that is, in the crucible—was not exposed to the same severe oxidising influences as with the newer processes mentioned. Consequently manganese was not then so necessary.

Manufacture in France.

In the Appendix to his Paper Kohn stated that the Terre Noire Company, then one of the largest and most successful Bessemer steelworks in France, employed a low-percentage grade of ferro-manganese, produced by means of the Henderson process, and averaging from 23 per cent. to 25 per cent. of metallic manganese. It will thus be seen that this French development originated from the English process of Henderson, and no doubt that explains why this Company later on, under the direction of Mr. Pourcel, were led to investigate the production of rich 80 per cent. ferro-manganese in the blast furnace, which they accomplished with great success, and thus finally solved this problem—one of the most important in ferrous metallurgy. The Company's earliest production of such alloys was exclusively used for the softest Bessemer steel required for boiler plates, ship plates, the construction of ordnance, and similar purposes. The knowledge rapidly spread, and in this way was introduced the mild

* From a Paper on "The Metal Manganese and its Properties: Also Ores and the Production of Ferro-Manganese and its History" read before the recent Annual Meeting of the Iron and Steel Institute.

steel of to-day. Thus the successful production of a new ferrous alloy led to the development and application of steel in directions not previously thought to be possible.

A considerable number of mechanical tests were carried out on this boiler-plate steel, made by the Terre Noire Company, by the late Sir William Fairbairn, Bart., who in those early days did so much to advance our knowledge with regard to the mechanical testing of iron, steel, and other materials. The average tenacity was about 27 tons per sq. in., with about 30 per cent. elongation and 57 per cent. reduction of area.

Mr. G. J. Snelus and Mr. Edward Williams made interesting contributions to the discussion on Kohn's Paper. Mr. Snelus pointed out that the Ebbw Vale Company had succeeded at that time (1870) in making spiegeleisen of very high class, as it was then termed, showing that such material could be obtained in England. He added that the production of spiegel containing 17 per cent. manganese was considered a great feat.

Sir Lowthian Bell conclusively proved, with unusual foresight, as might have been expected from so eminent a metallurgist, that the presence of manganese was of great benefit. He said that "until they had some better means of testing that oxygen can exist dissolved in the iron, he must for one dissent from the statement that the office played by manganese is that of freeing it from oxygen in solution merely."

Such were the beginnings of the manufacture of mild steel, which has revolutionised the world by enabling constructions to be produced which were not before possible. This was all due to the metal manganese and its wonderful effect in improving the quality of the steel, a matter which nowadays we take for granted. It is therefore interesting to see the gradual steps which led to this important advance in metallurgical practice.

With regard to the then early production of ferro-manganese, it is stated in Kohn's book that the manufacture was commenced at the suggestion of Sir Henry Bessemer, by Mr. W. Henderson of Glasgow, who invented a process, taking out a number of patents between the years 1860 and 1869 for the production of alloys of iron and manganese containing a high percentage of the latter metal, consequently with a lower ratio of carbon content to the percentage of manganese present, thus enabling a softer and milder steel to be obtained. It may be of interest, therefore, to see how this early production of ferro-manganese came about. It is a most interesting development, because it involves reference to the Bessemer process, which in its early days almost came to grief owing to ignorance of how necessary the use of manganese was for its success.

Sir Henry Bessemer's Paper, entitled "The Manufacture of Malleable Iron and Steel Without Fuel," when read before the British Association, at Cheltenham, on August 13, 1856, was not received with much enthusiasm, and the "Proceedings" of the Association did not even contain an abstract of it, merely mentioning the bare title of the Paper without comment.

As Bessemer experienced difficulty in getting licensees to work his process, he set up in Sheffield, in 1859, the works which are still known as Messrs. Henry Bessemer & Company. The author's relative, Sir John Brown, was one of the first to become an important licensee under the Bessemer patents. It is stated that during the life of Patent No. 2639, of February 11, 1856, Bessemer received over £1,000,000 in royalties alone.

In 1865 a further Paper was read by Sir Henry Bessemer before the British Association on the "History of the Bessemer Process." It was there stated that, at the suggestion of the author (Bessemer), a small works for the production of manganese alloys was erected by Mr. Henderson at Glasgow, who then made a very pure alloy of iron and manganese containing from 25 to 30 per cent. of the latter metal, and possessing many advantages over spiegeleisen.

Sir Henry Bessemer also stated, and his original words are quoted: "A Prussian gentleman, Herr Prieger of Bonn, had been successful in manufacturing a new alloy which he called ferro-manganese, consisting of 60 to 80 per cent. of metallic manganese. It was found to be extremely useful in making malleable iron by the Bessemer process, in which spiegeleisen could not be employed on account of the large proportion of carbon it contained."

The Henderson Process at Glasgow.

A Siemens furnace was erected for carrying out the Henderson process at the Phœnix Foundry, Glasgow. The process was worked by Messrs. Thomas Eddington & Sons, and consisted in reducing upon the open-hearth a mixture of carbonate of manganese and oxide of iron in the presence of excess of carbon by means of a neutral or reducing flame. The manufacture was commenced in 1865, apparently with good commercial results at first, and certainly with the greatest success so far as the quality of the product was concerned. The price of the metal produced by Henderson depended upon its percentage of manganese, namely, for each percentage of the metal manganese contained in the ferro-manganese there was paid £1 per ton. The average price of spiegeleisen in England at that time was £7 per ton.

This manufacture of ferro-manganese was, however, prematurely discontinued as an unprofitable branch, notwithstanding the complete success from the technical point of view. Kohn says this was the only instance he could find at that time of a retrograde movement in the metallurgy of iron!

Kohn read his paper before the Iron and Steel Institute in 1870 at the meeting held in Merthyr Tydfil, and presented a further note on this at the annual meeting in London in March, 1871. His book, entitled "Iron and Steel Manufacture," published in 1869, was certainly unique at the time and contained exceedingly valuable and useful information to the metallurgists of that day. The author can speak from his own experience of the valuable nature of the work, as in his own Company's works at Sheffield some of the plant still in use there was designed from the information given in Kohn's book.

It may be safely stated that the credit for having successfully solved the problem of the production of ferro-alloys in the blast furnace, and at prices commensurate with the needs of steelmakers for this material, belongs to Mr. Alexandre Pourcel and to his colleagues, Messrs. Valton and Euverte, at the Terre Noire, La Voulte and Bességes Foundry and Ironworks Company. Their experiments were, for the most part, carried out from 1875 to 1885.

To show how completely Mr. Pourcel had solved the problem of producing ferro-manganese—let it be remembered that this was nearly half a century ago, when chemical and metallurgical knowledge were in their earlier stages of development—the author gives some data obtained from a translation he made at that time of the particulars given in the Terre Noire Company's brochure issued at the Paris Exhibition of 1878. It may be said that present-day products are practically the same as Mr. Pourcel was able to provide so long ago.

Mr. Pourcel himself, with characteristic modesty, assigns the actual credit for the first successful attempts experimentally to make ferro-manganese to Prieger, of Bonn, who made the material in a crucible. It is to be remarked, however, that as far back as 1830, or thereabouts, David Mushet had made a material of the kind that would now be regarded as a ferro-manganese of low grade, and, as already mentioned, similar products were being made on a commercial scale as far back as 1865, in Glasgow, by W. Henderson. The work of Mr. Pourcel was, however, on quite a different scale and resulted in the material which, by the crucible process, cost no less than £80 to £100 per ton, or by Henderson's process, about £56 per ton, being at once reduced to £16 per ton—a truly remarkable achievement at the time. This figure was later reduced to the extraordinarily low selling price of about £8 per ton.

Various records show that Robert Mushet and his father, David Mushet, were much interested in experiments with this metal. David Mushet's book, published in 1840, entitled "Papers on Iron and Steel, Practical and Experimental—A Series of Original Communications made to the 'Philosophical Magazine,' chiefly on those Subjects," gives an account of a number of his experiments, and singularly enough, in some of them the non-

magnetic qualities of the material produced are mentioned. There is no doubt, however, that these specimens were more in the nature of spiegel than ferro-manganese.

Early Litigation.

After referring in some detail to the patents and experiments of Robert Mushet, the author goes on to remark that in the past manganese has indeed been a troublesome metal, being connected with several unpleasant differences. For example, to quote from Percy's "Metallurgy," and in reference to the legal proceedings in which Heath was involved in defence of his patent, "The result of fifteen years' litigation by Heath (in which no less than eighteen learned Judges, Privy Councillors and noble Lords took part) was that of the eleven Judges, the Lord Brougham and the Lord Chancellor, seven were in favour of and six against the claim of Mr. Heath; of the eleven Judges who delivered their opinions to the House of Lords, at the final stage of the proceedings, seven were in favour of and four against the claim of Mr. Heath; and the House of Lords decided in conformity with the opinion of the minority."

How and why ferro-manganese developed in place of spiegel was described by Mr. G. Magniny, of the Fonderies, Forges et Aciéries de Saint-Etienne, in his interesting monograph presented in April, 1925, in connection with the celebration of the Sixtieth Anniversary of the entry into industry of Mr. Pourcel. It was there pointed out that steel ship-plates were produced from Bessemer steel in which spiegel was used to convey the necessary percentage of manganese. As the spiegel contained 5 to 6 per cent. carbon, the steel produced was necessarily somewhat high in carbon, and the ship-plates so made often broke owing to lack of toughness in the steel. Mr. Pourcel, knowing of the existence of ferro-manganese prepared in the crucible, with carbon 6 per cent. and manganese 60 to 70 per cent., therefore replaced the spiegel with ferro-manganese and produced a steel with only one-fourth the former percentage of carbon. It was thus in 1867 that the Terre Noire Company delivered the first ship-plates in mild Bessemer steel.

In working out this problem Mr. Pourcel was assisted by Mr. Valton, the chief engineer of the works in question. Their combined researches showed that steel with low carbon was much less brittle, and incidentally that it resisted sea-water corrosion much better.

Mr. G. Magniny pointed out that we in England were the first to carry out the reduction of manganese ore into its metallic form, ferro-manganese, by means of the reverberatory furnace; in the Henderson process installed in Glasgow, the method of producing ferro-manganese on a carbon hearth gave products much less costly than the ferro-manganese produced in the crucible. To use Mr. Magniny's own words, "This process, which constituted a real and marked progress, was installed at Terre Noire in 1869."

Then Mr. Pourcel, naturally desiring to reduce the cost of producing ferro-manganese, conceived the idea of solving the problem by establishing and installing methods of producing ferro-manganese in the blast furnace. The great difficulty in the way was to avoid the lining of the blast furnace being attacked, but, as Mr. Magniny says, the Henderson furnace method gave him the necessary idea, and that was quite sufficient, namely, to replace the silico-alumina bricks by carbon bricks. This idea was at once put into operation.

Full information regarding his experiments was published by Mr. Pourcel * in a series of articles published in 1885; later reproduced by Moissan in Fremy's "Encyclopédie chimique." The author has prepared the following notes which embody, with certain interpolations of his own, the gist of Mr. Pourcel's interesting account, in the series of articles referred to above, of the experiments made at the Terre Noire Works. As, moreover, they refer to the work of Henderson and of Prieger, and show how that work laid the foundations of the successful manufacture of ferro-manganese at Terre Noire, they are of special interest in the present connection.

* "Genie Civil," May, 1885

The articles in *Génie Civil* relate to work carried out at Terre Noire during the period comprised between the years 1866 and 1883. Mr. Pourcel defines ferro-manganese as pig manganese containing over 25 per cent. of manganese. Below 25 per cent. of manganese, manganiferous pig-iron is commercially termed spiegel, and when the percentage falls to between 5 and 7 per cent. it is called "small spiegel" (*petit spiegel*). He points out that at that time (1883) some metallurgical works only included in the term ferro-manganese pig metal containing 40 per cent. of manganese and upwards, a classification he regards as purely fanciful. The line of demarcation depends, he says, upon the fact that the magnetic properties of iron are completely annihilated by the presence of 24 to 25 per cent. of manganese. Thus rich spiegel containing 24 per cent. of manganese, when reduced to powder, still clings to a magnet, whereas when the percentage rises to 25 it is no longer attracted.

This line of demarcation between spiegel and ferro-manganese is sharply accentuated by a fact more tangible than any indication furnished by crystallisation could be. Indeed the lamellar fracture of spiegel, with large white and very brilliant plates, only becomes modified by gradual stages between 25 and 50 per cent. manganese, and it is not until 50 per cent. that they present decidedly the basilar crystallisation or the amorphous grained texture, which becomes more and more distinctly marked in proportion as the percentage of manganese increases.

Development of Manufacturing Processes.

The phases of the manufacture of 80 per cent. ferro-manganese at the Terre Noire Works were as follows:—

At the beginning of 1868 it was made in crucibles. In the following year the Siemens open-hearth was employed, and this method exclusively used until 1875. In that year the manufacture of ferro-manganese was commenced in the blast furnace.

The Henderson alloys were first used for the production of mild Bessemer steel by Mr. Valton in 1865; in 1867 the new 80 per cent. ferro-manganese was used in Bessemer steel for the first time, 20 kg. being added to the casting ladle containing about a 3-ton charge. The ingots were remarkably free from pipe. Some of them were used at the works; others were sent to Fraïsans, where they were made into sheets and subsequently exhibited with mention of the origin of the metal. Thus the Terre Noire Company were able to claim for themselves the application of ferro-manganese to the manufacture of mild steel, and the fundamental revolution which this wonderful metal—"described to-day as soft iron or blown metal"—was to produce in engineering constructions of all types was already appreciated at that time.

As regards the manufacture of ferro-manganese in the blast furnace Mr. Pourcel says: "My Company (Terre Noire) commenced to see the possibility of the manufacture of ferro-manganese in the blast furnace when we found that the Société Industrielle de Carniole had sent to the Vienna Exhibition in 1873 specimens of this product, obtained in the blast furnace by treating a mixture of spathic ore and oxide of manganese." However, as mentioned by Gruner in his description of the exhibit, this ferro-manganese did not contain more than 30 per cent. manganese, and the furnaces producing it could only do this for a few days without damage to the lining. Only lack of the necessary Cowper stoves delayed the Terre Noire Company from immediately following up the implied hint. This, however, was done in 1874, and interesting details of the furnace design and of the practice followed are given. Trouble was experienced with high-ash coke, but the difficulties were gradually surmounted, and a graphic account of the means whereby success was eventually attained is given in the article.

In connection with such details it may be of interest to point out the extreme importance of having proper refractories and furnace linings. The author has been favoured with some notes from Mr. J. M. Storey as to the type of bricks used by the Darwen and Mostyn Iron Company, Limited, in their own ferro-manganese furnaces. They contain approximately 55 per cent. SiO_2 and 37 per cent. Al_2O_3, and are used with special

clay. Such bricks have been found to stand up well to the work, and to be better than any others.

Manufacture of Ferro-Manganese.

To give a detailed account of the manufacture of ferro-manganese would be beyond the scope of the present Paper. It may, however, be pointed out that for its production in the blast furnace high-grade ores are necessary, and that the process of smelting is apt to be expensive, not only because of the price of such ores, but also because the coke consumption of a blast furnace working on such a burden is much higher than when ordinary iron ores are smelted for the production of pig-iron. Three tons of coke per ton of ferro-manganese produced is by no means an unusual consumption, but with carefully-selected ores and coke of the most suitable description the consumption may be brought down to about 2 tons per ton of ferro-manganese. The loss in manganese may, moreover, be considerable, particularly if the furnace is working at too high a temperature, when much of the metal may pass into the slag, and this is also liable to occur if insufficient coke is charged.

The Joint Report of the two American Societies, to which reference has already been made, estimates the losses of manganese during smelting and kindred operations at from 15 to as much as 35 per cent. The average loss at ferro-manganese furnaces operating during the war at the works of the United States Steel Corporation is said to have amounted to 28 per cent. That at "spiegel furnaces" is said to have been higher (30 per cent.).

Ferro-manganese produced in the blast furnace almost invariably contains appreciable percentages of carbon, from which it is almost impossible to divest it. Ferro-manganese produced in the electric furnace can, on the other hand, be obtained with comparatively low carbon. Into the reason for this it would not be possible, within the limits of this Paper, to go in any detail, and for similar reasons the effect of the presence of silica, lime, alumina, and phosphoric acid, on the working side of the charge, and that of such other impurities as zinc, copper, etc., cannot, in this connection, be further dealt with. It is claimed that the electric furnace yields a purer product, and that the nature and grade of the product are under better control. Electric processes, however, are not very efficient in other respects, and the product, owing to the heavy consumption of current, is expensive. The losses, due to the greater volatilisation at the high temperatures employed, are also apt to be heavy, and the utmost skill and much experience are required in working an electric furnace for the production of ferro-manganese, if losses from these and other causes are not to become prohibitive. The cost of ferro-manganese produced in such circumstances is therefore higher than that of the blast-furnace product. The manufacture of silico-spiegel and spiegel, however, is almost invariably carried out in the electric furnace at the present time. On the other hand, the production of ferro-manganese in the blast furnace is the better and more economical process, although for certain kinds of work, where high purity is required, ferro-manganese produced in the electric furnace may have advantages.

The late Dr. J. E. Stead, F.R.S., in his presidential address to the Iron and Steel Institute in 1920, stated that the losses which occurred in smelting manganese ores amounted to 20 per cent. Apparently a similar figure applies to British present-day practice. From figures kindly supplied to the author by the late Mr. F. Sutcliffe, of the Darwen and Mostyn Iron Company, it appears that for each ton of manganese in the ore smelted 1 ton of 80 per cent. ferro-manganese is produced, containing 0.80 ton of manganese, thus representing a loss of 20 per cent.. The larger part of the loss goes into the slag, and the remainder is carried away as flue-dust and vapour. Mr. Sutcliffe stated that unfortunately the composition of the slag and flue-dust is such as to render the manganese content of little or no value.

The chief factor in determining the purity of ferro-manganese is the phosphoric acid content in the ore, rather than the process by which it is made. The author has had before him British ferro-manganese in which the phosphorus content is exceedingly low, so that by care and attention during the process of manufacture there is no doubt that the blast-furnace method can well hold its own.

The oldest electrical processes for the production of ferro-manganese are the Gin process and the Hofer process. In the former, dehydrated sodium sulphate is added to the ore, previous to its reduction by carbon in the furnace. In the Hofer process calcium fluoride is employed, and reactions take place in which both silica and phosphorus are volatilised and so eliminated. Ores which contain these constituents can therefore be treated by the Hofer process, although unsuitable for direct reduction in a blast furnace.

Dr. J. E. Stead, F.R.S., in his Presidential Address in 1920 already referred to, devoted one section to the consideration of the manufacture of spiegel and ferro-manganese. When speaking of the historical side and referring to the early days, about 1870 to 1875, he mentioned that in his own experience with the German and Ebbw Vale spiegeleisen at the Gorton Steelworks of Messrs. Bolckow, Vaughan & Company, Limited, in 1872, the higher manganese in the latter made a great difference to the hot-working properties of the steel. Red-short cracks, common when the German material was used, practically disappeared, and, instead of having to cold-dress nearly every hammered bloom, little dressing was necessary.

He further stated that, following the advantage derived from the use of higher manganese, and with the availability of the manganiferous ores of South Spain, the Ebbw Vale Company soon produced material containing from 17 to 20 per cent. manganese. Messrs. Bolckow, Vaughan & Company, Limited, in 1873, at their Witton Park Works, were the first to produce a similar quality on the North-East Coast. Other makers in Sheffield and elsewhere soon followed. Within a year or two little or no German spiegeleisen was used in the manufacture of rails in this country.

Then came Pourcel in 1875, and, as narrated elsewhere, solved the problem of producing rich ferro-manganese in the blast furnace, containing 40, 50, and eventually up to 85 per cent. manganese.

Great credit is due to British makers for the way in which they developed this important manufacture. Table II gives the names of the British makers of ferro-manganese, the number of furnaces they employ, and their capacity per annum.

It may be interesting to add that amongst deliveries to the author's firm in 1892 was material containing no less than 88.88 per cent. manganese—quite a metallurgical feat. In the early days of the manufacture of spiegel, which came from the Continent, it was thought quite a triumph to obtain 12, 16, or 20 per cent. manganese in the spiegel.

As regards any improvement in the manufacture of ferro-manganese, there seems to be but little difference in the type and quality compared with that of the material which originated with Mr. Pourcel in 1875. The author, however, points out that it would be very desirable and useful if ferro-manganese could be produced containing under 0.05 per cent. of the metalloid phosphorus. There is no doubt that for special purposes such a product would be of much practical service.

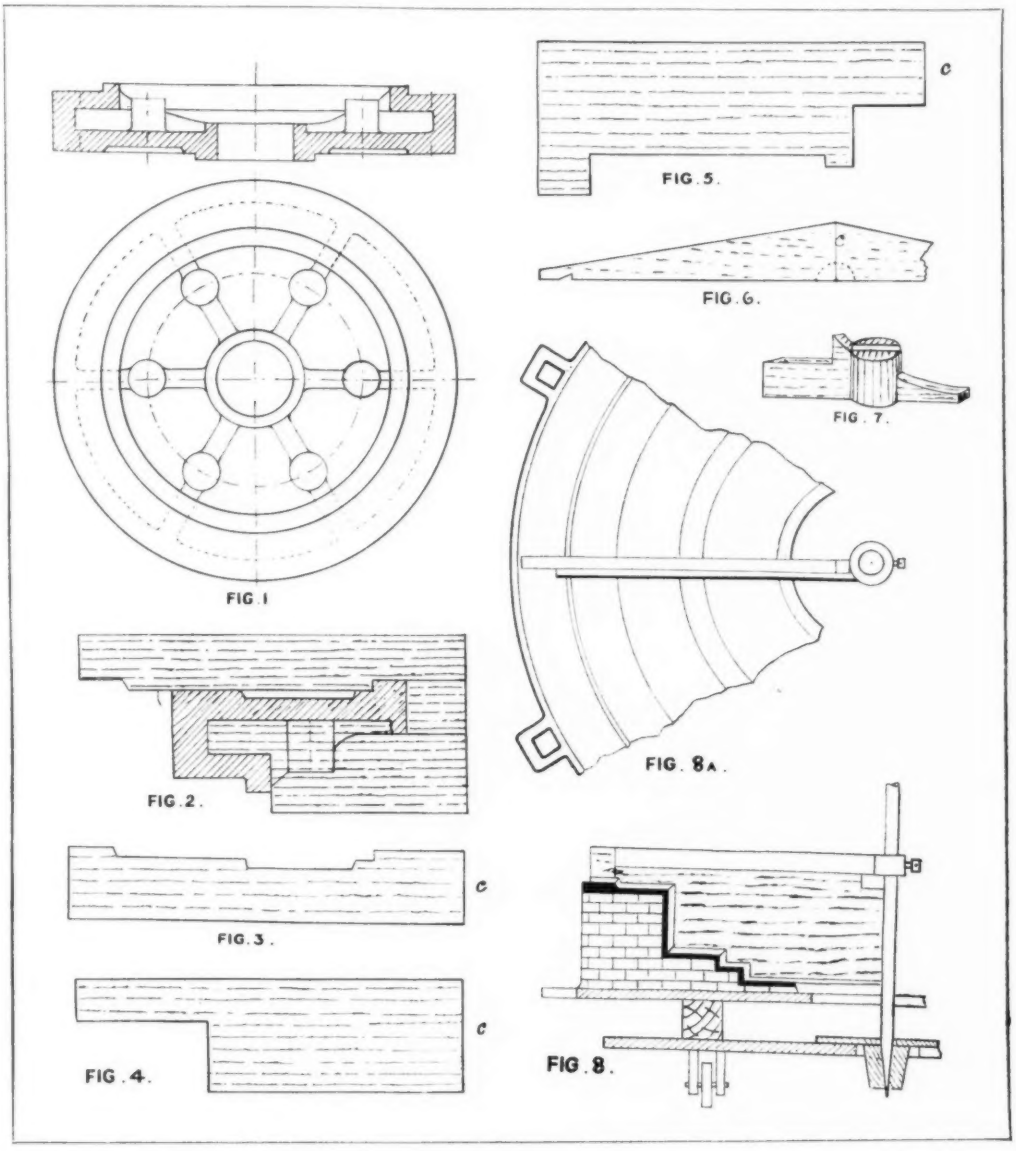
TABLE II.—*British Makers of Ferro-Manganese and their Output Capacity.*

	Number of furnaces.	Capacity per annum. Tons.
The Darwen and Mostyn Iron Company, Limited	5	75,000
Dorman, Long & Company, Limited	2	45,000
Linthorpe, Dinsdale Smelting Company, Limited	2	45,100
United Steel Company (Workington Iron and Steel Branch) ..	1	25,000
Bolckow, Vaughan & Company, Limited	1	25,000
Wigan Coal and Iron Company, Limited	1	25,000

A Centralising Disc in Loam.

By Ben Shaw and James Edgar.

Loam is particularly useful in the making of moulds for large castings which are circular in shape, especially when but few similar castings are required. The centralising disc shown in Fig. 1 is a good illustration of the type of work for which loam is well suited as a medium for taking the necessary shape. This casting is used as a base for centring large gear blanks for turbine reduction gearing preparatory to the gears being cut on a special machine. It is therefore provide a bearance and guide for the top or cope part. On this board it is customary to draw the sectional view of the casting and paint in the metal thickness for use in the foundry. The top or cope board shown in Fig. 3 forms the remainder of the outer shape, and is extended to form the guide to match that on the bottom board. The core is of such a shape that a core-box board, shown in Fig. 4, is prepared in this instance, and the core board, Fig. 5, is prepared



a one-off job, and the making of a pattern would incur needless expense. The amount of pattern work necessary for preparing the mould in loam is comparatively small, merely consisting of a number of boards having a profiled edge similar to the required shape of the casting, and these can be prepared and sent to the foundry in a very few hours. Two sweeping boards are necessary for the mould and two for the core.

Tackle Required.

The main board for the mould, known as the bottom board, and shown in Fig. 2, is so formed that it represents the sectional outer contour of the casting to the highest point on the periphery. The shape of the board is extended beyond the shape of the casting, at the bottom to provide a print for the core, and at the outer part to to form the top shape of the core. It is an advantage to have a clearly defined line on this board to indicate the centres of the bosses on the ribs. These boards should be made from timber about 1½ in. thick, and, unless the diameter of the spindle which is to be used in connection with them is known, it is best to leave the centre on each board. A gauge stick, Fig. 6, cut to the extreme diameter of the casting, and having the thickness of the metal indicated, is necessary as a check in setting the boards and for testing the mould after it has been formed. Apart from these boards the only pattern work required consists of six ribs similar to that shown in Fig. 7. It is an advantage when making these to take into consideration their position in the core when it is being swept and reduce them by about $\frac{1}{16}$ in. so that the board will clear. All the sweeping

boards are chamfered to reduce the striking edge to about ¼ in. in thickness, and the side on which the chamfer is cut depends upon the customary method of rotation preferred in the foundry, whether clockwise or anti-clockwise.

Starting Operations.

If the casting is required urgently the preparation of the mould and core can proceed simultaneously, which prevents any loss of time in producing the casting. In each case they are preferably prepared on a bogie for convenience in transferring to a drying oven. The bogie plates used for this class of work have provision for securing a centre plate having a machine tapered hole into which a turned spindle fits accurately. A substantial foundation plate is supported on the bogie plate, as shown in Figs. 8 and 8a, upon which the bottom of the mould is built. The sweeping board for this part, having been cut to suit the diameter of the spindle used —usually from 2 in. to 3 in.—is secured so that it fits against the spindle. A spider or tailpiece

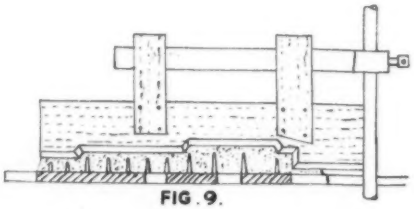


FIG. 9.

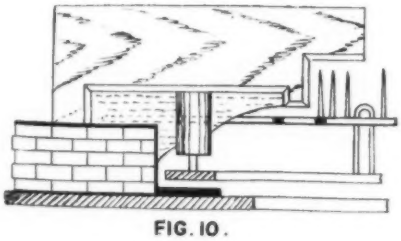


FIG. 10.

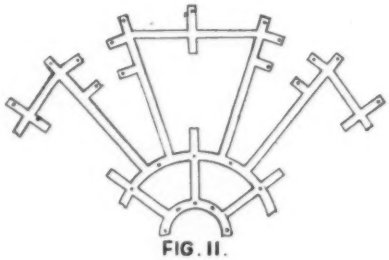


FIG. 11.

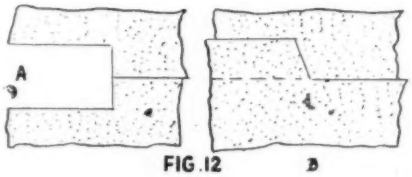
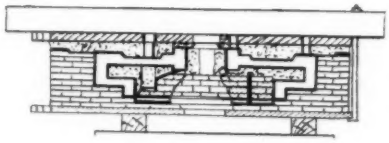


FIG. 12



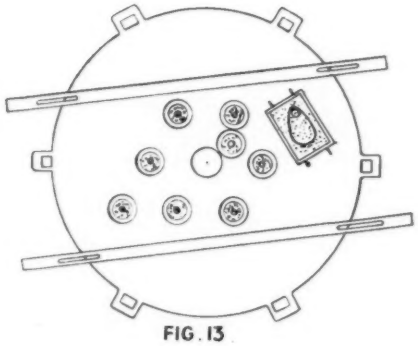


FIG. 13

carries a number of gaggers to assist the loam in adhering to it. The plate must also possess a number of holes conveniently placed for runners and risers. When sweeping this part, dried loam is introduced into the working loam during the operation in order to stiffen it against sagging when the final sweeping is done. After it is swept and while it is green the gates and risers should be cut. When the bosses on the ribs are fairly large it is an advantage to have a riser from each; therefore their position must be accurately marked on the cope. To facilitate marking a small nail is sometimes knocked in the cope board at the required distance from the centre so that a mark is made on the cope upon which the centres of the bosses can be more easily located. The method of preparing the core is illustrated in Fig. 10. A core box or seating is swept out by means of the board provided, and it is allowed to stand until the loam becomes stiff before a commencement is made on the core.

This core box is then used in the same way as a wood box. A ring plate, having suitable staples is fixed to the spindle by the stud shown in Figs. 8 and 8a, and either bolts or clamps are used to secure the board to the spider.

Moulding Details.

When the board has been set and checked with the gauge stick the operation of building can begin. Loam is applied to the surface of the foundation plate and bricks bedded into it, the whole of the shape outside the profiled edge board being built with bricks interspaced with loam, but leaving at least ¾ in. between the board and the bricks for facing loam. During the operation of building the board is rotated with the spindle to determine the position of the bricks. Loam is applied to the inside and top of the brickwork, and the board sweeps the shape desired, the loam being thinned with water to obtain a smooth finish with the final sweeping. It will be noted that this board is chamfered for sweeping anti-clockwise. Fig. 9 shows a part of the bottom after it has been swept, and incidentally the position of the board relative to the spindle. The method of sweeping the mould cover is very similar, but, since the top is prepared in an upside-down position, no bricks are used: instead, the plate upon which it is swept cast in for lifting, is bedded into loam applied to the bottom of the core box; then it is necessary to mark off the position of the ribs and set them relative places in the loam box. Bricks and loam are built on the ring plate until the ribs are bedded in their required position, and a coating of loam is applied to the top surface of the core box. A grid is necessary to carry the projecting part of the core, and for this purpose the type shown in Fig. 11 is suitable. This grid is clay-washed and bedded into the loam on the surface of the core box and bolted or clamped to the lifting ring. The bricks used in building the core will maintain the required distance between the grid and the plate, or small packing pieces may be necessary between the bricks and grid at the places where bolts or clamps are used. When this grid has been set the core board can be secured to the spindle and the remainder of the core swept up.

Blacking Loam Moulds.

It may be necessary to adjust the ribs so that their centres coincide with the mark indicated on the board. Both parts of the mould and the core are conveyed to an oven to be dried, after which they are carded where necessary and coated with blacking and again dried. The blacking is

used to give a better skin to the casting and also to cause the sand to peel from it more readily when cleaning. It consists of mineral blacking to which has been added a small proportion of plumbago; sometimes clay-water is added as a bond, but more frequently an artificial bond is used in the mixture. Some bond is, of course, necessary, as neither mineral blacking nor plumbago will adhere to the loam. The mixture has water added until it has the consistency of cream, and it is painted on the dried loam. Some discretion is necessary in its application, especially when applied to the loam while it is hot from the stove. There is a tendency to use the swab brush too generously as an aid to making a smooth surface, and the majority of the blacking is removed, resulting in a roughened surface on the casting.

Finishing the Mould.

When the various parts have been thoroughly dried the mould can be assembled and prepared to receive the molten metal. The core is lowered and located by the print swept out at the bottom of the mould; the holes about the staples in the core are then filled up and hot bricks used to dry the sand; the top can then be turned over and lowered into its position. Before this is done, however, it is wise to card the outside part of the guide on the bottom at three or four places. This is necessary to enable the moulder to determine when the top coincides with the inside bearance. Although the ordinary spigot and socket guide is more frequently used, many prefer what is known as the feeler joint for work of this kind. Fig. 12 shows the two methods, the feeler joint being indicated by A. In this form of guide recesses are swept out of both top and bottom parts of the mould, and when closing the top is moved until the peripheries coincide, when the opening at A is filled with loam. Once the top has been correctly located with the risers directly over the moulds for the bosses it can be clamped down, and runner and riser basins set in position. A sketch of the mould is shown in Fig. 13. It will be noted that cast-iron bars are carried over the top and bolted to the bottom plate; clamps or bolts are also used between the snugs on the top and bottom plates. When the mould is secured against lifting, the metal can be poured. This method of moulding such a job provides a good casting, and no other method can compare with it for cheapness when only one is required.

Sulphur in Brass.

BY "CELSIAN."

The scarcity of technical literature dealing with the effect of sulphur in brass at the present time is greatly to be deprecated since commercial brass almost invariably contains a minute proportion of this impurity. It is well known that nearly all metals are capable of forming compounds with sulphur, either at elevated or normal temperatures.

In the case of ferrous metals, strict directions may readily be adhered to with regard to the proportion of sulphur present in pig-iron and steel. The influence exerted by sulphur on these metals is so well comprehended that in specifications restricting the proportion of the impurity to 0.05 per cent. directions can readily be carried out; otherwise rejection of the order would probably ensue.

On the other hand, the limiting percentages of sulphur in brass is rarely specified. It is evidently taken for granted that tests on the subject are unnecessary, or at least unimportant. This is one reason why the presence of this impurity is blamed by workmen for all the defects that metal is predisposed to. Whether in rolling, brass splits, develops blisters during annealing, proves too hard or displays a red instead of a yellow colour, sulphur is the scapegoat in each case.

The frequency with which their noses are reminded of the presence of sulphur, which is almost never entirely absent in industrial brass, is doubtless responsible for the operative's theory. Workmen, highly skilled in the manufacture of brass, are in all likelihood not acquainted with the physical structure of the metal. Even those familiar with the physical aspect of the question are often at a loss to determine whether or not sulphur is responsible for trouble.

The structure of brasses of the same composition, although clearly defined under examination, vary so greatly that products from different manufacturers are not distinguishable. Even in successive castings in the same shop variety of structure is experienced under certain conditions.

Brasses employed in engineering may be separated into two important classes—the alloy, 70 per cent. copper and 30 per cent. zinc, frequently called cartridge brass, representing one class and 60-40 alloy representing the other. The composition of brasses of the latter class almost invariably deviate from the recognised standard of 60 per cent. copper and 40 per cent. zinc, mainly in accordance with the special methods adopted by different manufacturers and also on account of the small proportions of other metals present. These may have been left from insufficient refining of the material, or they may have been added during manufacture for specific purposes. The presence of a higher percentage of either of the latter than is desirable in some cases is attributed to using scrap in manufacturing billets from which products may be rolled or extruded. The use of scrap is also frequently the origin of the intrusion of impurities in alloys. Those may be either metallic or non-metallic When of the latter type they are sometimes of a very infusible nature, and become entrapped in an irregular fashion in the mass. Non-metallic impurities which are fusible at temperatures below the melting point of the metal are, to a certain extent, soluble in the liquid metal and are found as globules at the granular boundaries of the mass. If the metal, while at high temperature, undergoes mechanical treatment at the rolling mill the globules are drawn out into thin threads.

On dissolving brass drillings in strong nitric acid, in extreme cases where the sulphur content is high, minute globules of the sulphur may be detected floating on the surface of the liquid.

Sulphur and Rolling Troubles.

One founder experienced great trouble in rolling his 60-40 brass, which led to investigations. The alloy had been manufactured from neglected scrap heaps consisting of hundreds of tons of spillings, sweepings and ashes with coke scattered throughout the mass. The coke was of first-class quality, but, for one reason or another, had never been separated. In time these neglected heaps had fired by spontaneous combustion, with the result that a considerable amount of the metal included in the heap fused together absorbing sulphur from the burning coke. Subsequently the mass was treated in a washing plant, after which the concentrates were melted to pig metal.

On analysis being conducted the average sulphur content of the resultant metal was 0.50 per cent., but some samples exhibited 0.72 per cent.

Castings of the alloy on being marketed were, in numerous cases, returned, the high sulphur content having been discovered. On experimenting with the metal in order to utilise it to the best advantage, tubes were made under ordinary factory conditions. These tubes gave no trouble in the drawing. Strange to say, no complaints were received after the tubes were marketed and in use for some time; therefore it was concluded that the presence of the forementioned percentages of sulphur in the alloy did not prevent its usefulness for this particular purpose.

In another case, where 60-40 brass had given trouble, analysis demonstrated that the sulphur content of several of the ingots was not more than 0.02 per cent., while others contained considerably less. They were all equally troublesome, master and man alike attributing the origin to the sulphur content. Analysis subsequently proved that the source of trouble lay in the casting.

It is claimed that minute proportions of sulphur may, under certain conditions, prove more harmful than larger percentages. With special ingredients in metals, such as manganese in steel and phosphorus in brass, the reversal of effect is well understood in larger or smaller proportions.

It has been repeatedly demonstrated that of all the different impurities present while working brass, sulphur is apparently the least likely to cause trouble.

XUM

German Iron Foundry Employers' Federation.

57th Annual General Meeting.

The Iron Foundry Employers' Federation held its annual general meeting on June 1 and 2 in Stuttgart, under the presidency of Dr. S. G. Werner, of Düsseldorf. There was a large attendance, which included many representatives of public bodies, technical institutions, German and foreign allied Associations, and the Press.

The first part of the proceedings was devoted, as usual, to sittings of the committees and the managing bodies of the Association, at which the most important questions and problems of an economic and technical nature were discussed.

Of special interest were the technical addresses delivered on the first day. Professor Heidebroek, Dr.Eng., of Darmstadt, dealt with "Bases for Rationalisation and Continuous Processing in the German Foundry Trade"; Professor Kessner, of Karlsruhe, on "Sand Ramming and Sand Strength, with Special Reference to Recent Moulding Processes"; and Herr Sipp, of Mannheim, on "The Development of Fettling Processes up to the Present Time."

Bases for Rationalisation and Continuous Processing in the German Foundry Trade.

By PROFESSOR HEIDEBROEK, Dr.Eng., Darmstadt.

To estimate properly the importance of continuous work in the foundry trade it is necessary to consider systematically the basis of the preparatory operations which lead to continuous work. The essentials of accurate preparatory work consist of three problems, viz., the arrangement according to time elements of the analysed total output in relation to (1) the worker, (2) the workshop, and (3) the casting work. In relation to the person working the labour elements are grouped under wages rates, piece-work times, task work, etc. The development is here such as to restrict more and more the time mobility of the worker, the course being from the time-wage system pure and simple by way of piece-work wages and time contracts to the so-called task ("pensum") system with the duration of the work definitely fixed. The initiative as regards diminishing the duration of the working processes is thus transferred from the worker or the workshop to those responsible for the preparation of the work.

The arrangement of the labour elements in relation to the place where the work is done leads to the systematic distribution of labour over all the work in hand with the view of attaining the highest possible degree of occupation.

In relation to the piece of work, the preparatory operations are based upon the idea of an uninterrupted course of labour, in the sense that the individual operations on the piece of work follow each other immediately. Work done by conveyors is the extreme form of continuous work, but it is also possible for the latter to be carried out even without any visible means of transport.

The realisation of the idea of proper processing leads to the elimination of interruptions in work and of storage intervals. In foundry work there already exists a fair degree of continuity. This might be improved, however, in particular departments, especially in the auxiliary sections dealing with core making, cleaning, etc. The adoption of continuity is of greater importance to foundries in connection with the necessary transport operations. An alteration in the spatial arrangement of the shops would be necessary immediately anything approaching mass production was required. Several technical solutions might be devised for the purpose, particularly the mechanical transport of the boxes from the moulding shop to the casting shop for discharge and back again to the moulding shop.

The use of high-speed moulding machines is rendering such measures increasingly necessary. Equally important, however, is the effect of continuity in the work of casting, and the fixing of the time for the various castings, particularly in respect of cutting out all unnecesary auxiliary labour. It also promotes the best solution of the distribution of labour, as it necessitates uniformity in the occupation of the working places.

Viewed as a whole, the adoption of a systematic method of work preparation in all three directions ought to lead to a considerable improvement in working conditions, while at the same time special importance must be attributed to the educative idea involved in continuous processing.

Sand Ramming and Sand Strength, with Special Reference to Recent Moulding Processes.

By PROFESSOR KESSNER, KARLSRUHE.

As a result of extensive research work in the industry itself and in the technical school laboratories, and by the gradual adoption of continuous production in foundries, the technical side of foundry work has undergone a development during the past few years such as could hardly have been anticipated. An extensive system of lectures in the various technical groups, and holiday courses excellently organised and conducted by experts at certain technical schools, particularly well equipped in regard to foundry work, have helped to give that work—the importance of which to all branches of industry was recognised much too late—a much more prominent place in the consideration of technical and scientific circles. If the technical literature of founding is studied, many purely scientific treatises are to be found, mainly of a chemical, metallurgical or technological nature, as well as descriptions of new foundry machines and equipments, economic and other studies, which all indicate progress in foundry work, to which, unfortunately, sufficient attention is not yet paid at all the technical institutions.

The lecturer devoted himself mainly to new experiments in the mechanical testing of finished moulds in iron and steel foundries. The experiments did not relate to specially prepared test pieces, but to finished moulds in which the sand was rammed by various processes employed in practice.

The determination of the sand compression in practice with working moulds shows very divergent values according to the method employed. Here it should be noted that moisture, clay content and size of grain in the facing and blacking sand have a considerable effect on the ramming work or sand compression, the permeability to gas and the bonding capacity. It is of the utmost importance to the foundryman that he should investigate the sand densities which are most favourable from these points of view and employ suitable processes for their regulation in practice.

A new process, differing from those hitherto employed in testing the density of the sand in flasks was described. In this a freely falling weight leaves a definite impression in the mould. The depth of penetration with a given impact energy serves as a measure of this specific sand density. To determine the bonding strength of the moulding sand rammed by any process, a sample of sand is picked out of the flask with a sheet-iron tube sharpened at the end, and is slowly pressed out by means of a screw spindle until the free end breaks off. The bonding strength is then ascertaied in accordance with the laws of the strength of materials precisely as if it were a question of an overhanging beam breaking off owing to its own weight. To determine the gas permeability a sample is lifted out with the same tube, from the rammed or pressed box and examined by the well-known process of Dr. Steinitz. The results clearly show the relation between the specific density of the sand, its bond strength and its gas permeability. These new testing methods have been adopted in different foundries. In this connection the lecturer mentioned that a new process of sand ram-

ming employed by the Badische Maschinenfabrik in Durlach was of special interest. In this the ramming is done by a compressed air centrifugal moulding machine, which effects a uniform compression of the sand in all the layers of the flask by means of a freely moving nozzle.

The Development of Fettling Processes up to the Present.

BY KARL SIPP, Mannheim

By "cleaning" a casting is understood the working processes necessary (a) to cleanse the castings coming from the moulds from the moulding sand adhering to their surface and from remnants of the core material in their interior, (b) to remove the gates, seams and flashes.

The processes necessary in cleaning may be divided into hand and machine work. While the operations mentioned under (a), the removal of moulding and core material, are performed by tumbling or shaking the castings, those under (b) are effected by cutting tools.

Until the end of last century the first category of operations was carried out almost exclusively by brushing off with steel brushes and knocking off by hand or by tumbling the castings in a barrel, and those mentioned under (b) by means of chisels, files or sandstone. The tumbling-barrel consists of a round or polygonal wooden cylinder with charging doors, which has axle extensions at the ends supported in bearings and is rotated by a suitable drive. The interior is filled with castings through the doors and the cylinder revolved. The castings are thus tumbled together and are freed from the remnants of sand by the ensuing scouring and jolting action. Against the simplicity of the apparatus in construction and use, however, must be set certain drawbacks. On the one hand, the work is not well-done, while castings which are not too strong are easily broken, and the appearance is spoiled by the hammering undergone by their surface; on the other hand, the dust produced has a very unpleasant effect in the immediate vicinity.

The increased requirements in regard to the external appearance of castings, combined, no doubt, with the desire to make the cleaning work less unpleasant for those associated with it, led to the introduction of the sand-blast apparatus. Even in 1892 Ledebur pointed out that the sand-blast apparatus, invented by the American Tilghmann, was known and in use in the early seventies. The action of this sand blast consists in throwing sharp sand—recently also grains of steel—by a current of air on to the casting to be cleaned, thus freeing the surface from sand and other impurities.

The principle of the system invented by Tilghmann, the so-called *suction system*, is that the air flows through a pipe, at its nozzle-shaped end sucks the sand out of another pipe as it sweeps past, and hurls it against the casting to be cleaned.

The *pressure system* differs from the suction system in that the sand container is placed under pressure, and the sand is carried through holes to the current of air which passes into the nozzle.

In addition to these two systems there is a third, the *gravitation system*, which differs from the two others in that the sand is not sucked or pressed, but is carried to the air current by falling freely from above. The compressed air required for the blower is produced by compressors and the pressure is generally 1-2 atm. Experiments with higher pressures have shown that no appreciable increase in output can be obtained by increasing the pressure beyond 3 atm.

Sand-blast apparatus may be classified as follows: (1) ordinary jet, (2) rotary table, (3) bar table, (4) roller table, (5) box blower, (6) drum blower, and there are also special types for particular purposes.

While the origin of the sand-blast apparatus must, as has been stated, be ascribed to America, it must be observed that to Germany is mainly due its development to its present form. Even in America it was not generally adopted until late. This fact is due in no small measure to the fact that Americans in general attribute less importance to the appearance of a casting than Germans, and that the improvement produced by sand blasting on the outward appearance of a casting has consequently not been appreciated in America to the same extent

In America the cleaning drum is in general use, but of late the rotary table has made some way alongside it and promises to come into more extensive use. This type works almost exclusively on the pressure system, and is therefore similar to the German types. The Americans pay special attention to the elimination of dust, but this is also the case in German foundries. Here a word may be said on the question of quartz versus steel shot. Reports have frequently been published in the technical press to the effect that in America the use of steel sand had had very successful results. German firms also have begun to sell steel shot. According to Geilenkirchen, however, the success in America does not appear to be so certain as to justify the assertion that steel shot is superior.

A comparison of German and American cleaning processes shows that there is uniformity up to a certain point, that any differences existing are not of a fundamental nature, and that these are rather a matter of temporal differences in the development of one or other method of cleaning. While in Germany the sand-blast apparatus was developed in the first place, in America more attention was devoted to the improvement of the cleaning drums. The Americans are now making more headway with the sand-blast process, while Germany, on the other hand, is doing the same with drums. It is well, moreover, that the cleaning drum is being more widely used in Germany, for the process has considerable advantages in the cleaning of certain types of castings.

In regard to the cleaning operations mentioned under (b), the chisel may still be regarded as an important tool. Formerly the hand chisel was used, but it was gradually replaced by the compressed air chisel, which works much more economically. The chisel plays the most important part in the removal of seams, gates and flashes, particularly in large castings difficult to handle. After the chisel the file is used. For small castings, on the other hand, it is customary to use the grindstone instead of the chisel and file. Sandstone, which was formerly used, has generally given way to emery stone, which is more economical in operation.

With these stationary types there have recently been associated others of a portable nature, which enable castings of any form and size to be treated by hand on the spot, thus usefully supplementing the work of the chisel. Circular saws are useful in removing runners and risers.

Some years ago it was reported in the press that water jets were being used in America as a means of cleaning. The apparatus consists essentially of a chamber in which a number of nozzles are arranged, which throw jets of water from all directions on to the casting placed on one of the tables, and wash off or out the moulding and core sand. At Lanz's, in Mannheim, experiments had previously been carried out for the purpose of testing to what extent water could be employed in cleaning, and for this purpose a boiler feed-pump for a pressure of 10 to 12 atm. was used. The tests showed, however, that the consumption of water was prodigious and that the economy of the process was doubtful. The experiments were continued, and higher water pressures were employed with smaller nozzles. Systematic tests with nozzles from 10 mm. downwards, and pressures from 20 up to 50 atm. showed that with increasing water pressure and a small cross section in the nozzles a favourable effect took place both in regard to disintegrating the sand and diminishing the water consumption. By shaping the nozzles angularly as well as rectilinearly it is possible to get into all the cavities and so clean the most complicated castings thoroughly. The economy of the process is in proportion to the intricacy of the castings. In addition, the core irons can be removed without injury and can be used again. The greatest advantage, however, is that the operation is effected without dust.

AN ARRANGEMENT has been entered into between Messrs. Carlo Brivio, of Via Principe Umberto, 25 Milan, and Automatic and Electric Furnaces, Limited, of 173-175, Farringdon Road, London, E.C.1, for the manufacture and sale of Wild-Barfield electro-magnetic furnaces in Italy.

XUM

Trade Talk.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, Springburn, Glasgow, have received an order for ten locomotives and tenders from the Sudan Government Railway.

A SECTION OF THE NEW WORKS being erected by John Russell & Company, Limited, iron, steel and tube manufacturers, at Rocksavage, Runcorn, will commence working in a few weeks' time.

A FIRE BROKE out last Friday week in the iron foundry at Vickers' Naval Construction Works, Barrow. It spread to the pattern store, which was completely destroyed, together with the works club and rifle range.

OWING to the depression in the Cleveland iron trade, Pease & Partners, Limited, have intimated their intention of closing down at the end of this week the two blast furnaces in operation at their Tees-side ironworks, Stockton-on-Tees.

MARSHALL, SONS & COMPANY, LIMITED, Britannia Ironworks, Gainsborough, are now taking up the manufacture of stone-breaking, granulating, screening and storage plants, gravel washing and screening plants, and conveying and elevating plants.

THE ALTOS HORNOS DE VIZCAYA have purchased the mines, railway and piers of the Luchana Mining Company, which was formed in 1886 to work ironstone mines near Bilbao, Spain, and the issued capital of £200,000 of which is held by Bolckow, Vaughan & Company, Limited, and John Brown & Company, Limited.

WHEN THE LATE Mr. Charles Markham, chairman of the Staveley Coal and Iron Company, Limited, set in motion the 7,000 horse-power gas engine at Devonshire Works, Staveley, about two years ago, he stated that the company proposed to instal two more engines of a similar size. The second has now been installed and was given a trial run on May 26. Work on the third has been begun.

THE FOLLOWING INTIMATION has been made to Messrs. J. C. Bishop & O. Coyle, joint secretaries of the Scottish Manufactured Iron Trade Conciliation and Arbitration Board, by Sir John M. MacLeod, Bart., Glasgow :—"In terms of the remit, I have examined the employers' books for March and April, 1927, and I certify that the average net selling price brought out is £11 14s. 9.64d. This means that there will be no change in the wages of the workmen.

THE MEMBERS of the Midland Association of Gas Engineers and Managers, who recently visited Dudley at the invitation of their president, Mr. F. C. Briggs, and directors of the company with which he is connected, were afforded opportunities of visiting the works at Netherton of N. Hingley & Sons, Limited, and those of Metallisation, Limited, who have introduced a new industry to the town in the form of metal spraying known as the "Schoop" process, of which they have secured the patent rights for this country.

THE DEPRESSED STATE of trade is reflected in an official circular distributed to the shareholders of Yates and Thom, Limited, engineers and boilermakers, Blackburn. Calling attention to an extraordinary meeting of the concern, at which a resolution was considered "that the company be wound up voluntarily," Sir Wm. Thom points out that the actual trading of the company during the last three or four years has resulted in a loss. On the other hand, dividends, and interest on investments and rents receivable by the company, have enabled them not only to pay all interest charges on debenture stock and preference shares, but also a dividend on the ordinary stock. Competition in their branch of the engineering industry, it is stated, is keener now than it has ever been. The steady advance in the use of electricity and the numerous large power stations erected in various parts of the country, were making great inroads into their business. This competition would continue, and become more severe. Every endeavour had been made to find new manufactures to increase output, but without success. The company was financially sound, but the general trading was being carried on at such a loss that a few more years under similar conditions would result in a loss to the shareholders, which to-day could be avoided. At present, the circular states, the company had sufficient assets to ensure payment in full of its outstanding debenture stock and creditors, and, in addition, 20s. in the pound to the preference shareholders, with the probability of a similar eventual payment to the ordinary shareholders.

SIR CHARLES J. O. SANDERS, the secretary of the Shipbuilding Employers' Federation, is retiring therefrom at the end of the month. He was entertained at dinner by the Federation on this occasion.

Personal.

SIR HARRY MCGOWAN, president and deputy-chairman of Imperial Chemical Industries, chairman and managing director of Nobel Industries, and chairman of the King's Norton Metal Company, Limited, has been elected a director of the Midland Bank.

MR. E. H. LEWIS, formerly works manager of the Glasgow Iron and Steel Company, Limited, Wishaw, has been appointed general manager of the company, in succession to the late Mr. Macaulay. Mr. Lewis for four years was president of the West of Scotland Iron and Steel Institute.

DR. H. R. WRIGHT, managing director of Siemens Brothers & Company, Limited, has joined the board of the British Columbia Telephone and Telegraph Company (a Delaware, U.S.A., Corporation, with its offices in Chicago), in which Siemens Brothers & Company, Limited, hold a substantial financial interest.

MERZ & MCLELLAN, consulting engineers, 32, Victoria Street, Westminster, London, S.W.1, announce the introduction of members of their engineering staff into partnership as follows: Mr. H. H. Baker with Mr. C. H. Merz and Mr. W. McLellan in the firm of Merz & McLellan; Mr. F. Lydall with Mr. C. H. Merz in the firm of Merz & Partners; Mr. R. Nelson and Mr. A. H. Human with Mr. W. McLellan in the firm of McLellan & Partners.

Wills.

BALFOUR, J., of Leven, of the firm of Henry Balfour & Sons, Limited, Dune Iron Foundry, Leven £13,505

GILLESPIE, W., of the Broomhall Engine Works, Glasgow £19,490

Contracts Open.

Alexandria, Egypt, June 14. — Iron and steel materials, metals, etc., for 1927-1928, for the Ministry of Communications, Ports and Lighthouses Administration, Alexandria. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,723.)

Galway, June 16.—3,600 yards 3-in. cast-iron spigot and socket pipes; also new engine and pump to pump 30,000 gallons per hour, for the Galway Urban District Council. The Town Clerk, Galway, Ireland.

Durham, June 16.—Cast-iron pipes, from 2-in. to 6-in. diameter, during six months ending December 31, 1927, for the Durham County Water Board. Mr. W. R. Ward, clerk, 25, Northgate, Darlington

Moffat, June 20.—230 tons of 6-in. dry-sand cast-iron pipes and special castings, for the Town Council. Messrs. J. and A. Leslie & Reid, engineers, 72A, George Street, Edinburgh. (Fee £1, returnable.)

Melbourne, July 13.—Plate bending and straightening rolls, for the Victorian Government Railways Commissioners. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,722.)

Melbourne, August 15.—One 55-ton capacity three-motor type, electrically-operated overhead travelling crane, etc., for the State Electricity Commission of Victoria. The Department of Overseas Trade, 35, Old Queen Street, S.W.1. (Ref. A.X. 4,727.)

Company Reports.

Consett Iron Company, Limited.—Payment of dividend on preference and ordinary shares passed.

Baker Perkins, Limited.—Net profit, £63,722; final dividend, 5 per cent., tax free, making 9 per cent., tax free, for year.

Stanton Ironworks, Limited.—Final dividend, 6 per cent. (actual), free of tax, on ordinary shares, making 10 per cent., free of tax, for year.

Glenfield & Kennedy, Limited. — Profit, £59,762; brought in, £53,694; staff pension fund, £4,250; reserve, £20,000; final dividend, 6 per cent. on ordinary shares, making 10 per cent., less tax; carry forward, £52,706.

Sir W. G. Armstrong, Whitworth & Company, Limited.—Brought forward, £645,391; available for interest for 1926, £140,582; interest charges for year, £671,792; net loss, £531,210; credit at December 31, 1926, £114,181, carried forward; certain ascertained losses written off and special provision made for further anticipated losses, mainly on civil engineering and other contracts, to extent of £833,574; these losses provided for out of sale of certain investments; in due course proposals for reconstruction and reduction of company's capital must be developed; scheme of arrangement between company and debenture stockholders and note-holders drawn up, and included five years' moratorium in respect of certain interest and sinking fund payments.

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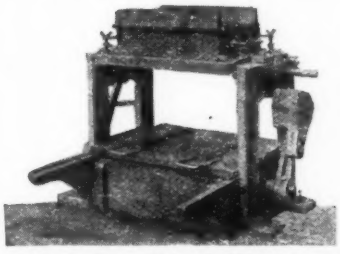

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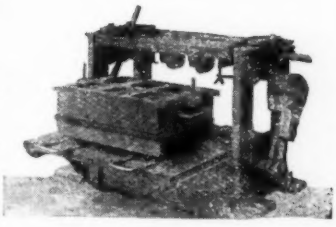

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IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—The Cleveland iron market closed for a brief holiday this week without visible signs of relief from the depression prevailing when last reported, both home and foreign demand being again in disappointing volume and buying reduced to almost retail proportions. How the position is to be retrieved it is impossible to say, but if no solution can be found the ironmasters are in for a bad time. However, there is no hint of further price cuts, and makers adhere firmly to the following quotations:—No. 1 Cleveland foundry iron, 72s. 6d. per ton; No. 3 Cleveland G.M.B., 70s.; No. 4 foundry, 69s.; No. 4 forge, 68s. 6d. per ton.

The market for hematite continues in about the same condition as previously indicated, but the recent curtailment of output seems to have been effective, and the placing of a few foreign orders with Tees-side makers has afforded some measure of encouragement—perhaps out of proportion to the volume of business. Meantime East Coast mixed numbers are quoted at 79s. per ton, with No. 1 6d. per ton extra. On the North-West Coast Bessemer mixed numbers are quoted at £4 8s. per ton delivered at Glasgow, £4 14s. per ton delivered at Sheffield, and £4 15s. to £4 17s. 6d. per ton delivered at Birmingham.

LANCASHIRE.—Consumers of foundry pig in this area are buying in limited lots only, and business generally is quiet. For local delivery Derbyshire No. 3 is quoted at 80s. 6d. to 81s. per ton, and Scottish is now obtainable at 98s., while hematites, both East and West, are 93s., including delivery.

THE MIDLANDS.—Local demand for foundry pig continues quiet, with prices inclined to lower levels. Northants No. 3 has dropped to 67s. 6d. per ton; Derbyshire is 72s. 6d. per ton, while North Staffordshire iron has been sold at slightly less than 72s. f.o.t. furnaces.

SCOTLAND.—As far as pig-iron is concerned, there is really no change in the position, the market continuing quiet and lifeless. No. 3 foundry Scotch iron is offered at 81s. at the furnaces, and no doubt for a decent parcel 80s. would be accepted.

Finished Iron.

Business in most branches of finished material continues quiet, especially in crown and cheaper qualities of bars. The lower prices which the works are prepared to accept are not having much effect, and the amount of new business is of disappointing proportions. Crown iron has been quoted at £10 10s. delivered South Staffordshire area, but the general level is between this and £10 15s. Nut and bolt iron is offered round about £10 per ton, but the demand is negligible on account of Continental competition for this class of iron. The bulk of this business goes abroad, Continental works quoting for their No. 3 iron about £6 per ton delivered into this area. The price for marked bars has been reduced to £13 10s. per ton at makers' works, and the mills engaged in making this iron remain fairly well occupied.

Steel.

Continental semis are now rather firmer than they were, but, as home users seem to be fairly well covered at old prices, the stiffening is not causing much concern. In South Wales the steelworks are becoming very badly off, and only a very few have any semblance of activity. Some of the furnaces are closing down, and it is doubtful when relighting will again be decided upon. There is now a difference of 21s. 6d. in the price of Welsh and Continental bars, the latter having firmed somewhat during the week. The tinplate market does not show signs of any improvement, and the demand is restricted. Several of the works are short of orders, and the output has been much restricted.

Scrap.

Conditions in the various markets for scrap metal remain depressed, and in Scotland heavy machinery cast-iron scrap is rather difficult to dispose of even at 75s. per ton. Heavy ordinary cast iron is easy at 67s. 6d. to 70s. per ton, in pieces suitable for foundries. Steelworks however, are paying the same price, 67s. 6d. to 70s. per ton, for heavy cast-iron scrap in furnace sizes. Old cast-iron railway chairs are commanding as high as 77s. 6d. per ton. Light cast-iron scrap is being sold fairly freely at 58s. 6d. per ton. The above prices are all per ton, delivered f.o.t. consumers' works.

Metals.

Copper.—Fluctuations in standard copper values at the end of the month were mostly inclined to lower levels, chiefly owing to depressing American cable advices, but subsequently a recovery occurred, due to the fact that the comparatively low level reached tended to stimulate new forward support for warrant metal.

Official closing prices of standard copper have been as follow:—

Cash: Thursday, £54 8s. 9d. to £54 10s.; Friday, £54 16s. 3d. to £54 17s. 6d.; Tuesday, £54 13s. 9d. to £54 15s.; Wednesday, £54 3s. 9d. to £54 5s.

Three Months: Thursday, £55 2s. 6d. to £55 3s. 9d.; Friday, £55 7s. 6d. to £55 8s. 9d.; Tuesday, £55 6s. 3d. to £55 7s. 6d.; Wednesday, £54 16s. 3d. to £54 17s. 6d.

Tin.—Conditions in standard tin have shown much irregularity of late, values on alternate days displaying extreme strength and weakness, but the chief supporting influence is the smallness of stocks in this country. Good quantities of tin, however, are being absorbed in the United States, and this is the mainstay of the position, some encouragement being derived from the report that consumers in America are very lightly stocked.

Official closing prices of standard tin have been as under:—

Cash: Thursday, £292 15s. to £292 17s. 6d.; Friday, £295 17s. 6d. to £296; Tuesday, £295 10s. to £295 15s.; Wednesday, £295 12s. 6d. to £295 15s.

Three Months: Thursday, £286 5s. to £286 7s. 6d.; Friday, £288 12s. 6d. to £288 15s; Tuesday, £288 15s. to £289; Wednesday, £288 15s. to £289.

Spelter.—The market for ordinary spelter has been again irregular, but the price for prompt delivery continues very well maintained, due to an improved demand from consumers, and has been quoted at a premium of 7s. 6d. a ton. The interest of consumers, however, has been unavailing to arrest the crumbling character of the market.

The following are the week's prices:—

Ordinary: Thursday, £28 17s. 6d.; Friday, £28 16s. 3d.; Tuesday, £28 17s. 6d.; Wednesday, £29.

Lead.—In soft foreign pig, over-production and the general holding back of the trade have tended to accentuate the depression, the price having recently dropped to £24 for prompt delivery. Compared with April 30, this indicates a depreciation of over £1 10s. a ton, and there is not the least sign of any improvement.

The week's prices are appended:—

Soft foreign (prompt): Thursday, £25 3s. 9d.; Friday, £25 7s. 6d.; Tuesday, £25 7s. 6d.; Wednesday, £25 1s. 3d.

Company Meeting.

Park Gate Iron & Steel Company, Limited.—A tribute to the late Mr. Charles Markham was paid at the annual meeting of the Park Gate Iron & Steel Company, Limited, by MR. DOUGLAS VICKERS, who has accepted the vacant position of chairman. Mr. Markham, he said, was one of the chief makers of the company. In reviewing the operations of the undertaking during the last year, Mr. Vickers mentioned that since Park Gate resumed work after the stoppage they had broken all previous records as regards output. Yet, in spite of this the revival in the steel and heavy trades, which was expected in the earlier part of the year, had not been realised. The reason for the activity displayed in some directions was due to the orders placed before the stoppage. New orders had not kept pace with the deliveries. He showed that last month they cleared their order books to the extent of 6,000 to 8,000 tons more than they took in. This he attributed to the large imports of steel from the Continent. With reference to the German and French proposals for restricting competition, he said his view was that it was only by combining together that they would ever be able to meet the competition.

New Companies.

Clayton & Shuttleworth (Overseas), Limited, Stamp End Works, Lincoln. Capital of £500 in £1 shares. Sale agents and commission agents, etc. Directors: C. T. Blacklock and G. Sturt.

A. Strauss & Company, Limited, 16, Rood Lane, London, E.C.3.—Capital £100,000 (25,000 preference £1, 75,000 ordinary £1). Metal brokers and merchants. Directors: G. R. Strauss, E. J. Tooley, C. O. Lee, and A. C. G. Hart.